Kendall Warm Springs Dace
(*Rhinichthys osculus thermalis*)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Cheyenne, Wyoming

September 2007

5-Year Review

Species reviewed: Kendall Warm Springs dace (*Rhinichthys osculus thermalis*)

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional or Headquarters Office - Mountain-Prairie Regional Office, 303-236-7400
Lead Field Office - Cheyenne Ecological Services Field Office, 307-772-2374

1.2 Methodology Used to Complete the Review

The U.S. Fish and Wildlife Service (USFWS) solicited information through a September 20, 2006, *Federal Register* notice (71 FR 55005). No comments were received as a result of that notice. USFWS also coordinated with staff of the Wyoming Game and Fish Department (WGFD), U.S. Forest Service (USFS), U.S. Geological Survey (USGS), and other expert professionals well-versed in the biology and status of the Kendall Warm Springs dace (KWS dace). Through coordination with expert professionals, we identified the type of information that would be most useful in completing the 5-year review process. We then developed our assessment of the current status of KWS dace.

In accordance with the peer review requirements of the Office of Management and Budget's Final Information Quality Bulletin for Peer Review, in Spring 2007 we initiated peer review of the science relevant to the draft KWS dace 5-year review. Peer reviewers included--Jon Sjöberg with the State of Nevada's Department of Wildlife; Pete Cavelli with WGFD; Allen Binns retired from WGFD; and Jeanette Carpenter with USGS.

1.3 Background

1.3.1 Federal Register Notice Announcing Initiation of This Review

September 20, 2006. Initiation of a 5-year review of KWS dace, Dudley Bluffs bladderpod, and Dudley Bluffs twinpod (71 FR 55005).

1.3.2 Listing History

October 13, 1970 (35 FR 16047) – listed as endangered under the Endangered Species Preservation Act of 1966 (80 Stat. 926; 16 U.S.C. 668aa(c)); "grandfathered" into the Endangered Species Act of 1973, as amended (ESA) on January 4, 1974 (39 FR 1171).
Entity listed: *Rhinichthys osculus thermalis*
Classification: Endangered

1.3.3 Associated Rulemakings

None.

1.3.4 Review History

May 21, 1979 (44 FR 29566) – review of all species (foreign and domestic listings) listed prior to 1975.
July 22, 1985 (50 FR 29901) – all species listed before 1976, and in 1979-1980 (foreign and domestic listings). Results: 1987 notice of completion.
July 7, 1987 (52 FR 25522) – notice of completion (no change) for reviews initiated in 1985.
November 6, 1991 (56 FR 56882) – all species (foreign and domestic listings) listed before 1991.

1.3.5 Species' Recovery Priority Number at Start of 5-year Review

The recovery priority number for KWS dace is 12, indicating that it is a subspecies with low recovery potential and a moderate degree of threat.

Recovery Plan or Outline

USFWS KWS Dace Recovery Plan was completed in 1982 (USFWS 1982). The recovery plan was updated in 1991 (USFWS 1991).

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment Policy

2.1.1 Is the species under review a vertebrate?
Yes.

2.1.2 Is the species under review listed as a DPS?
No.

2.1.3 Is there relevant new information for this species regarding the application of the DPS policy?
No.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective measurable criteria?

While a recovery plan was approved in 1982 (USFWS 1982), objective measurable criteria for achieving recovery and/or downlisting were not addressed. Instead, intermediate recovery actions were identified to ensure that the population was maintained until it could be determined that KWS dace was a valid subspecies. Once it was concluded that KWS dace was a valid subspecies, then the recovery plan was updated with a brief addendum (USFWS 1991). However, objective measurable criteria to achieve recovery also were not developed and included in the 1991 update. To date, the most thorough list of recovery actions are found in the 1982 recovery plan. Therefore, in this 5-year review, we report on the current status of the intermediate recovery actions as identified in the 1982 recovery plan. Development of objective measurable criteria for recovery of KWS dace should be the focus of a future revision of the 1982 Recovery Plan and the 1991 update.

2.2.2 Adequacy of Recovery Actions

2.2.2.1 Do the recovery actions reflect the best available and most up-to-date information on the biology of the species and its habitat?

No. Some current threats such as the threat of oil and gas development in the Kendall Warm Springs recharge zone and the potential introduction of exotic species are not adequately addressed.

2.3 Recovery Actions and Discussion

TABLE 1.
Status of Recovery Actions Summarized From Kendall Warm Springs Dace Recovery Plan

	SUMMARIZED RECOVERY ACTIONS	Completed	Ongoing	Partially Completed
1	Maintain population at or above existing levels		X	
2	Monitor population		X	
3	Monitor habitat conditions		X	
4	Monitor effectiveness of protective measures			X
5	Conduct law enforcement activities		X	
6	Ensure ESA compliance		X	
7	Conduct taxonomic studies	X		
8	Conduct geologic/hydrologic study	X		
9	Conduct life history studies			X
10	Construct new bridge crossing	X		
11	Conduct Research Natural Area evaluation	X		

(1) Maintain the existing population and habitat through present management direction, maintain a reproducing population at or above existing levels, and monitor to determine if all age groups present.

Since the time of its listing, KWS dace population has been maintained both by (1) protection of habitat and (2) the cessation of human activities that negatively affected KWS dace in the past.

Prior to the population census of June 2007, all available data suggested that the population was stable, all age classes of the dace were present in the population, and all available habitat was occupied (USFS 2006). Relative abundance estimates using catch-per-unit-effort (CPUE) as an index of abundance were completed in 1995, 1999, and 2005 (Gryska 1996; Gryska et al. 1997; USFS 2006). No significant differences had been observed over time. These results, along with visual evidence – abundant fish seen swimming throughout 2005, batches of fry observed several times during 2005, and large catches in minnow traps (over 5,800 captures were made in 2005) – suggested that the population in 2005 was very similar to previous observations (USFS 2006).

However, data from the June 2007 population census, currently being analyzed (J. Neal, USFS, pers. comm., December 8, 2006), suggest lower population levels than have been observed on previous sampling years. Lower population levels may be the result of recent drought conditions in the watershed and corresponding lower water discharge from the spring and reduction in available habitat.

(2) Develop criteria and procedures to monitor changes in population levels, and monitor to determine changes in population levels.

Gryska (1996) developed protocols and reported his success with population monitoring of KWS dace by measuring relative abundance as CPUE. Gryska et al. (1998) reported relative abundance and lengths of KWS dace captured in different habitats. Population monitoring protocols as developed by Gryska (1996) were repeated in 1999, 2005, and 2007. Total fish population estimates were not generated with the procedure.

Although a monitoring technique was developed, Gryska (1996) and USFS (2006) did not obtain an estimate of the total population size for KWS dace at any one point in time. Population size could not be estimated because standard mark-recapture methodologies required more handling (e.g., tagging fish) than was allowable for this endangered species. There is no expectation that population size estimates will be attained unless mark-recapture techniques are employed or less invasive population size estimation techniques are developed.

(3) Maintain the biological and physical integrity of stream habitat (includes monitoring habitat conditions, periodically inspecting springs and enclosure to assess habitat conditions and identify any problems with trespassing by livestock and people, establishing photographic and/or biological stations to document habitat conditions and trends, preventing adverse modification of existing habitat, maintaining present fencing to effectively exclude livestock grazing, continuing restrictions on unauthorized vehicle use adjacent to Kendall Warm Springs Creek, and continuing onsite Interpretation and Education program through interpretive sign).

Hubbs and Kuhne (1937) and Binns (1978) described the characteristics of KWS dace habitat. Binns (1978) measured chemical properties of the springs, temperature, water flow, and specific conductance. As Kendall Warm Springs is easily accessible and located on a major route leading to the heavily used Green River Lakes recreational area, the dace's habitat is regularly observed by USFS personnel while enroute to perform other duties in the Bridger-Teton National Forest. No official protocol for regular monitoring of KWS dace habitat is currently followed. No photographic and/or biological stations have been established to document trends in habitat conditions over time. The fencing surrounding the Kendall Warm Springs is currently maintained by USFS to prevent livestock (e.g., cattle) entry. The interpretive sign for KWS dace population is still present and in good condition.

USFS personnel have noticed one change to the habitat of KWS dace. Since livestock and people have been excluded, there has been an apparent narrowing and deepening of the stream channel and there has been an apparent reduction in the number of shallow, backwater nursery areas for the dace fry (J. Neal, USFS, pers. comm., December 8, 2006). However to date, there has been no effort undertaken to quantify such changes to the dace's habitat.

(4) Monitor effectiveness of present protective measures and implement measures or changes in present protective measures if needed.

Although the effectiveness of the ongoing protective measures themselves have not been evaluated, all available habitat for KWS dace is occupied and the population appears stable suggesting that the protective measures implemented have been effective.

(5) Enforce laws protecting KWS dace and its habitat. Monitor the area to prevent illegal taking of the dace. Implement law enforcement responsibilities in instances of taking.

Signs located onsite clearly inform visitors that wading and bathing in the springs and stream are not permitted. USFS law enforcement personnel patrol the Kendall Warm Springs for law violations and issue citations for illegal activity. We know of one instance where citations were issued to persons caught wading or bathing in the warm springs.

During a permitted 2005 research sampling of the population, four KWS dace traps were tampered with. One (most visible from the road) disappeared completely during a day set, two appeared to be partially stepped on by a wild ungulate, but still caught fish on night sets, and one was removed from the stream and placed atop an algae mat. Five KWS dace were found dead in that trap on the morning of June 23, 2005. USFWS Ecological Services personnel in Cheyenne and Law Enforcement personnel in Casper were notified the morning of these deaths. The deceased specimens were preserved in alcohol and sent to the University of Wyoming as stipulated in the sampling permit. We know of no other cases of illegal taking of KWS dace.

(6) Ensure compliance with section 7 of the ESA by Federal agencies responsible for activities that may affect KWS dace or its habitat.

USFS has coordinated and consulted with USFWS over two actions which may affect KWS dace--(1) KWS dace biological unit management plan [USFS 1978] and (2) a bridge crossing [USFS 1997]). Additionally, to remain in compliance with other sections of the ESA, appropriate permits have been secured prior to collecting or studying KWS dace (e.g., USFWS permit number PRT-704930, subpermit #95-52 for USFS in years 1995, 1996, and 1997), subpermit #TE-106387 for USFS in 2005, FA/SE/Blanket Permit, subpermit #86-16 for the University of Montana research team in years 1986, 1987, and 1988).

(7) Determine the taxonomic status of KWS dace (includes conducting taxonomic studies to determine if KWS dace subspecies differentiation is valid; identifying techniques to accomplish taxonomic study; recommending agencies and/or personnel to conduct studies, initiating and completing studies; determining the effect of rearing temperature on scale and fin ray counts, and head, fin and body size of the speckled dace through artificial propagation; determining thermal preferences of KWS dace and speckled dace; examining the relationship between KWS dace and speckled dace in the Upper Green River through biochemical genetic studies; evaluating results of taxonomic study; identifying additional actions needed to accomplish study if results are inconclusive; identifying taxonomic status base on results of study; recommending delisting if subspecies status is invalid; continuing to implement and revise existing recovery plan as needed if subspecies is determined to be valid.)

A number of studies have been completed which concluded that KWS dace is a distinct subspecies (Kaya et al. 1989; Gould and Kaya 1991; Kaya et al. 1992). Kaya et al. (1989, 1992) compared morphometrics, thermal tolerances, and biochemical genetics of KWS dace with its closest relative, the speckled dace of the upper Green River drainage in Wyoming. Gould and Kaya (1991) showed the pharyngeal teeth of KWS dace differ from speckled dace.

Kaya et al. (1988) also called for breeding and raising KWS dace in a laboratory setting at a range of temperatures to document whether or not they take on characteristics of speckled dace when raised/developed under those conditions. Attempts at breeding KWS dace in the laboratory were unsuccessfully attempted by Kaya et al. (1988).

(8) Conduct a geologic/hydrologic study of the springs and surrounding terrain.

A hydrogeologic evaluation of the Kendall Warm Springs was completed and a potential recharge zone was delineated (Mattson 1998). According to Mattson (1998), the warm nature of the Kendall Warm Springs indicates discharge from a deeply circulating flow system. That study reported that water emerging at Kendall Warm Springs may be circulating as deep as 2,953 feet (ft) (900 meters (m)), indicating it may be part of a deep regional groundwater flow system. Typically, water associated with deep regional flow systems have long flowpaths and move slowly. Groundwater residence times may be centuries to millennia and recharge may occur some distance away from the springs (Mattson 1998). The recharge area of the springs was estimated to occur between the Wind River Thrust and the Bacon Ridge Anticline - a region 21,270 acres (ac) (8,593 hectares [ha]) in size (Mattson 1998).

Records found indicated that a drillhole associated with historic oil and gas development, located south of Kendall Warm Springs about ⅓ mile (0.53 kilometer [km]), had previously been drilled to 1,810 ft (552 m) and encountered limestones and dolomites almost the entire length. A second drill hole, located 100 ft (102 m) east of the first, reported encountering water at 335 ft (102 m) below the surface. Water inflow increased as the hole advanced, and drilling ceased at 512 ft (156 m) due to the high inflows. No records were found documenting whether the waters encountered were thermal, or if the interception affected discharge at Kendall Warm Springs. These records indicated that a zone of high permeability, likely a water-bearing fault was encountered (Mattson 1998).

(9) Complete Life history studies. Identify other research needs. Complete additional research needs.

Kaya et al. (1989, 1992) studied thermal tolerances of KWS dace and Green River speckled dace. Gryska (1996) developed population monitoring protocols and described several aspects of the life history of KWS dace. Observations on the reproduction, sources of mortality, and diet of KWS dace were studied (Gryska and Hubert 1997) as well as relative abundance and lengths of KWS dace captured from different habitats (Gryska et al. 1998). Other aspects of KWS dace life history (e.g., fecundity, sex ratios, age at maturity, longevity) have not yet been thoroughly investigated.

(10) Evaluate an alternate road location or bridge crossing.

USFS completed section 7 consultation on the construction of a bridge over the Kendall Warm Springs and then completed the project (see USFS 1997). The bridge replaced a road culvert allowing reconnection of the dace's formerly disjunct habitat. Section 7 consultation was conducted because of potential effects to KWS dace including reconnection and siltation of its habitat caused by the construction work. Our files only include information regarding upgrading the bridge crossing. Our files include no information regarding the alternative proposal of re-routing the road around Kendall Warm Springs so that it did not cross the fish's habitat.

(11) Evaluate the potential for designation of the Kendall Warm Springs ecosystem as a Research Natural Area.

Fertig (1995) evaluated the Kendall Warm Springs area for its potential as a Special Management Area and as a Research Natural Area. He determined that past land use activities in the Kendall Warm Springs area make the site unsuitable for Research Natural Area designation. The existence of a major access road through the area and culverts and rock dams on the warm springs stream have altered the pristine nature of the site, making it poorly suited to serve as a reference or comparison area for scientific research. Fertig (1995) found that the area does qualify for designation as a Special Management Area; however, to date, the Kendall Warm Springs site has not been officially designated as such.

2.4 Current Species Status and Updated Information

2.4.1 Biology and Habitat

The Kendall Warm Springs area is located on the east bank of the Green River in the northwestern Wind River Range, approximately 30 air miles (48.5 km) north of Pinedale, Wyoming (Figures 1, 2, 3, 4, 5). The warm springs themselves remain a constant 85°F (29.4°C) year-round. The stream, fed solely by the warm springs, is 984 ft (300 m) in length and supports the world's only population of KWS dace. The stream temperature is more variable than the warm springs and has been recorded as low as 78°F (25.6°C) in the winter at the point where it cascades over a waterfall into the Green River. The peripheral areas of the stream have been recorded as low as 52°F (11.1°C) in the winter.

KWS dace adults (Figure 6) range in size from 0.9 to 2.1 inches (in.) (23 to 54 millimeters (mm)). Breeding males have been characterized as having a bright purple color, while females are dull olive green (Hubbs and Kuhne 1937). Gryska (A. Gryska, Alaska Department of Fish and Game, pers. comm., December 19, 2006) only observed the olive-green coloration during his research efforts although he handled several thousand spawning males with nuptial tubercles. Most adult dace live in or along the main current of the stream, while dace fry are commonly found away from the primary flow. Small shallow pools located in beds of aquatic vegetation are well utilized by fry. Many small shallow pools are created by the hooves of elk and moose. The creation of the pools appears to be beneficial. Tiny, apparently newly hatched dace are common from the second pool downstream to the outfall in all seasons (Binns 1978).

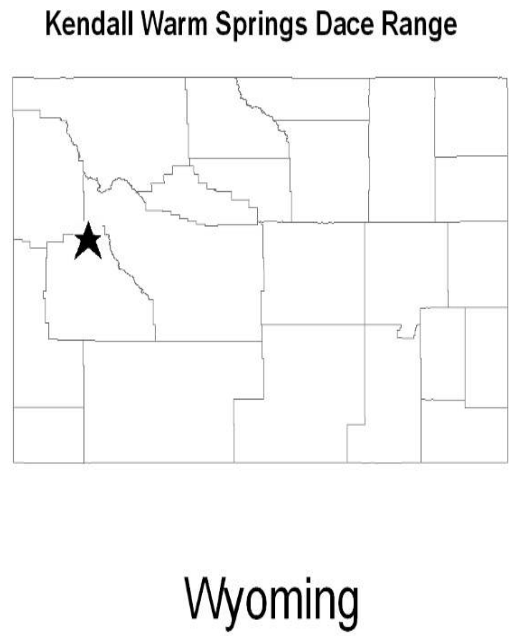


FIGURE 1.
Location of Kendall Warm Springs Dace Population

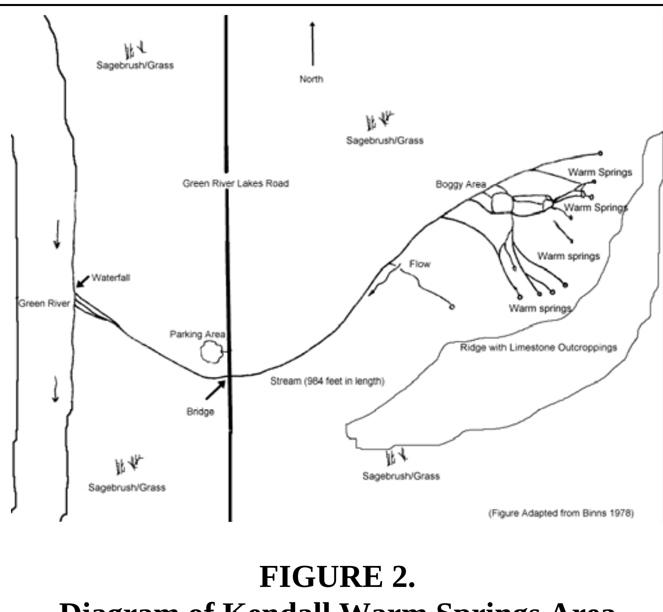


FIGURE 2.
Diagram of Kendall Warm Springs Area

Photo from Binns 1978

FIGURE 3.
Aerial View of Kendall Warm Springs Looking West

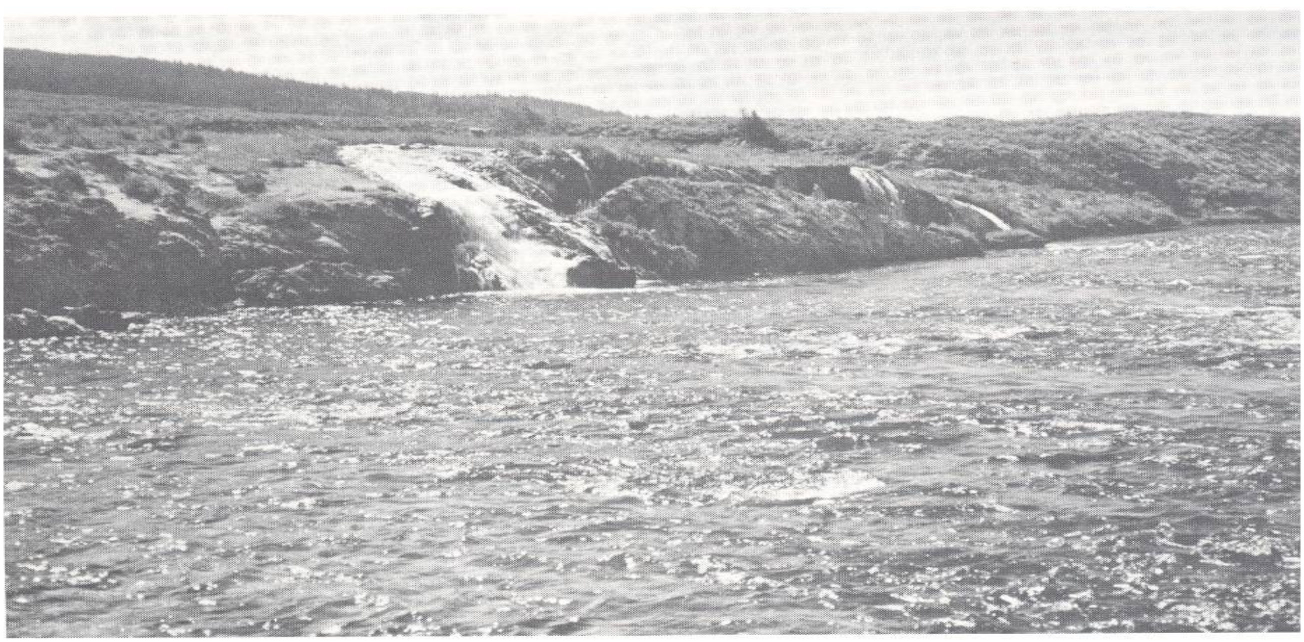


Photo from Binns 1978

FIGURE 4.
Waterfall Showing 3-meter Drop From Kendall Warm Springs Stream to Green River Below

Photo provided by U.S. Forest Service

FIGURE 5.

Kendall Warm Springs Stream Looking to the North From Atop Limestone Bluff

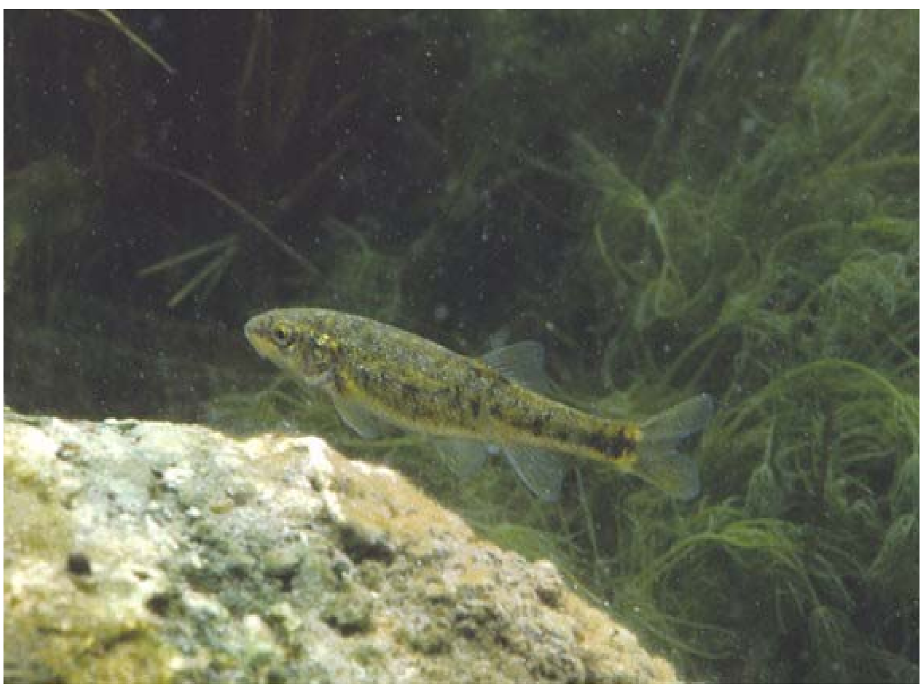


Photo taken by LuRay Parker, Wyoming Game & Fish Department

FIGURE 6.

Kendall Warm Springs Dace

The species spawns year-round although Gryska and Hubert (1997) found evidence that reproduction decreases in the winter. They witnessed very few larval fish along the shoreline and the number of drifting larvae was substantially less in January than in May through August. Additionally, Gryska (1996) captured significantly fewer juvenile and adult fish in traps during winter than during summer, and mean length of fish captured in January was significantly greater than in summer (Gryska and Hubert 1997). Gryska and Hubert (1997) proposed two potential reasons for the decline they witnessed--(1) an overall reduction in primary productivity due to shorter winter days and reduced intensity of sunlight, and (2) cooler winter water temperatures in the shallow, near-shore larval fish habitat. It appears that photoperiod and/or water temperature may have an influence on reproductive rates (Gryska and Hubert 1997).

Stomach analysis of KWS dace indicates they feed on benthic invertebrates and epiphytic organisms (Gryska and Hubert 1997). They suck and scrape invertebrates from the substrate by using a subterminal mouth specialized for benthic foraging. Benthic invertebrates occurring in the Kendall Warm Springs stream include Odonata (*Argia*, *Erythemis*), Trichoptera (*Cheumatopsyche, Hydroptila*), Coleoptera (*Elmidae, Hydrophilidae*), Diptera (*Heleidae, Stratiomyiidae, Tendipedidae, Tipulidae*), Amphipoda (*Hyalella azteca*), Hydracarina, and Gastropoda (*Lymnaea, Planorbidae*) (Binns 1978).

KWS dace often form small aggregations (Figure 7). No information is currently available describing whether these fish have defined home ranges or if they display territoriality. Numbers along the creek seem to correlate with dissolved oxygen and carbon dioxide levels with fewer fish upstream and none at all at the spring source. Adult KWS dace inhabit fairly shallow pools and stream not more than 1 ft (0.31 m) in depth. Plant growth within the water is necessary for escape cover and protection from the main current. Fry also utilize the vegetation as nursery areas (USFWS 1982).

Plant growth provides the primary escape cover for KWS dace. A skittering flight to the nearest clump of plants is the typical predator avoidance reaction, although some also flee to the deeper, turbulent areas of the main current (Binns 1978).

According to Mattson (1998), the warm nature of Kendall Warm Springs indicates discharge from a deeply circulating flow system. Depth of circulation may be estimated using the thermal gradient and given the site conditions, water emerging from the Kendall Warm Springs may be part of a deep regional groundwater flow system. Typically, water associated with these systems has long flowpaths and moves slowly with residence times in the aquifer of centuries to millennia (Mattson 1998). Assuming that the springs discharge from a regional flow system, recharge may occur at some distance away from the spring sources. This is an important consideration in assessing potential impacts of projects on the population and its habitat.

Photo provided by U.S. Forest Service

FIGURE 7.
School of Kendall Warm Springs Dace

2.4.1.1 New Information on Species' Biology and Life History

Recently observed males have not been found to be purple in breeding condition. Gryska and Hubert (1995) observed ripe adults and larval fish breeding during the winter, although evidence suggests that reproductive output decreases during this season (Gryska and Hubert 1997). Gryska and Hubert also noted that the fish have a wide thermal tolerance. Gryska and Hubert (1995) determined that KWS dace cannot be aged using scales or opercula due to the failure of the fish to form annuli in the isothermic spring. The use of otoliths as an aging technique has not been attempted.

2.4.1.2 Abundance, Population Trends, Demographic Features or Trends

The presence of dace can easily be verified by walking along the stream. Management objectives as listed in the Bridger-Teton National Forest Land and Resource Management Plan (LRMP) (USFS 1990) are to maintain the existing population and protect its habitat. Hubbs and Kuhne (1937) thought the population size of KWS dace ranged between 200,000 and 500,000 individuals, but they did not perform a study to determine abundance.

Developing an index of relative abundance for KWS dace began in 1995 using CPUE of trapping as a measure of trends in the population size (Gryska 1996). Traps were designed to capture the dace without being destructive to the habitat of the fish. Daytime traps were set between 0700 and 0900 hours and retrieved between 1900 and 2100 hours. Nighttime traps were set between 1900 and 2100 hours and retrieved between 0700 and 0900 hours. Retrieved traps were placed in a bucket containing water from the stream. The trap was opened and captured fish were released into the bucket or tub for enumeration (see Figure 8). Fish measurements were made from photographs to minimize handling stress. Fish were then released back into the stream (Gryska 1996). USFS has continued this effort in 1997, 1999, 2005, and 2007.

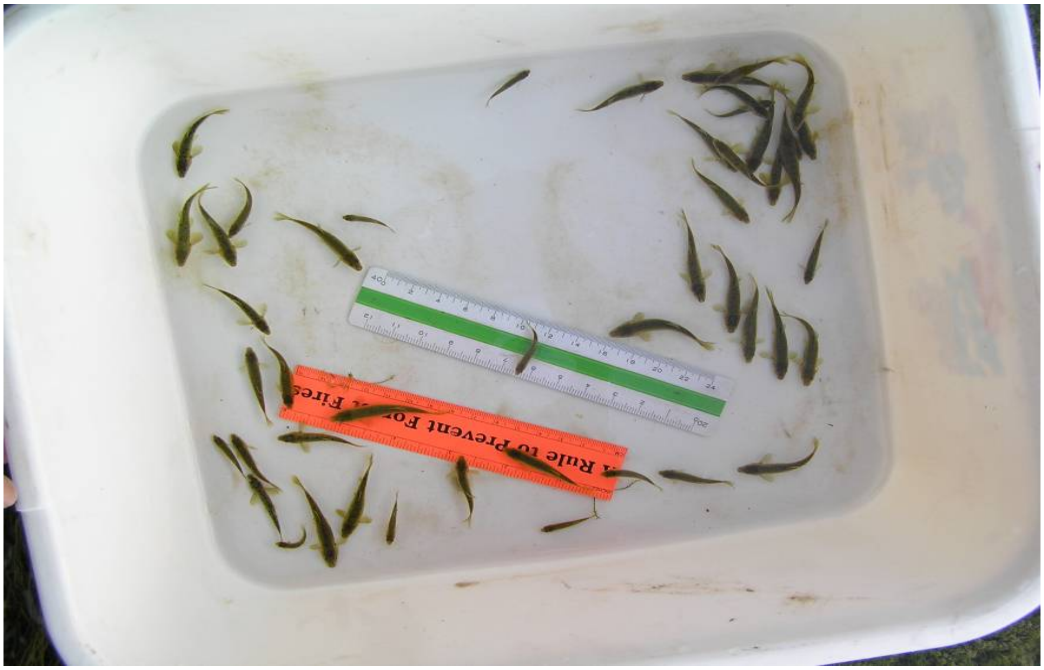


Photo provided by U.S. Forest Service

FIGURE 8.

Photograph Showing Dace in Tub with Rulers

Results from the 1997, 1999, and 2005 population monitoring efforts showed that the CPUE means were not significantly different between monitoring years. This, along with visual evidence – abundant fish seen swimming throughout 2004 and 2005, batches of fry observed several times during 2005, and large catches in minnow traps – suggest that the population in 2005 was very similar to previous observations (USFS 2006).

However, preliminary analysis of data from 2007 indicate lower population levels. Specifically, mean CPUE in 2007 was roughly half of mean CPUE in 2005. Lower population levels may be the result of recent drought conditions in the watershed and corresponding lower water discharge from the spring and reduction in available habitat.

Gryska and Hubert (1997) found that KWS dace regularly drifted over the waterfall and into the Green River during all months that they sampled. Of those, 75% were larval fish and 25% were either juveniles or adults. Although they postulated that their estimates may have been low, they estimated that at least 75 larval fish per day drifted from the creek (a total of about 9,200 fish during the months of May through August). This was attributed to the relatively poor swimming ability of the larvae once they entered the swifter current. Using density counts of individual quadrats, Gryska and Hubert (1997) estimated that a total of at least 24,000 larval fish were present in the stream in June. Drift of juvenile and adult KWS dace from the stream was estimated to be 25 fish per day during the months of May through August (about 3,000 fish) (Gryska and Hubert 1997).

2.4.1.3 Genetics, Genetic Variation, or Trends in Genetic Variation

According to Kaya et al. (1989), the most important morphological difference between KWS dace and speckled dace is pharyngeal teeth. They found that KWS dace lack pharyngeal teeth in at least one minor row in 85% of the cases, whereas speckled dace lack this characteristic in less than 1% of the cases. Electrophoretic examination of 26 loci showed no variants at any locus in either population, and both populations fixed at all loci. However, 5 of 12 restriction enzymes revealed polymorphic mitochondrial DNA (mtDNA) in speckled dace, whereas only 1 enzyme showed polymorphic mtDNA in KWS dace. One of the alternative mtDNA in KWS dace was not found in the speckled dace. For two other enzymes, KWS dace was monomorphic for banding patterns not found in speckled dace. The differences in mtDNA and pharyngeal teeth indicate genetic and morphological differentiation between KWS dace and the adjacent Green River speckled dace.

2.4.1.4 Taxonomic Classification or Changes in Nomenclature

KWS dace was originally described as a subspecies of the western dace (*Apocope osculus)* (Hubbs and Kuhne 1937). Later work on the fishes of Wyoming designated KWS dace as *Rhinichthys osculus thermalis*. The taxonomic certainty of KWS dace as a distinct subspecies has been discussed by many investigators (Hubbs and Kuhne 1937; Binns 1978; USFWS 1982; Kaya et al. 1989; Gould and Kaya 1991; Kaya et al. 1992). Studies by Gould and Kaya (1991) and Kaya et al. (1988, 1989, 1992) concluded that KWS dace is a distinct subspecies.

2.4.1.5 Spatial Distribution, Trends in Spatial Distribution, or Historic Range

KWS dace is confined to one stream approximately 328 yards (300 m) in length which originates at a series of thermal springs near the base of a bluff. At the time of its listing as endangered, its habitat was fragmented into two sections by a road built across the stream prior to 1934. The road culvert bisected the stream at a point approximately ⅔ of the way downstream from the stream’s origin. The road culvert has since been removed and replaced with a bridge which spans the stream (USFS 1997) allowing reconnection of the habitat. The habitat ends with a waterfall approximately 3 m in height which plunges downward to the non-thermal Green River below. KWS dace are believed to occupy their entire historic range (Hubbs and Kuhne 1937; Kaya et al. 1992). Future monitoring efforts may need to address changes in spatial distribution and habitat use if in fact changes in habitat characteristics and conditions are occurring (as discussed below).

2.4.1.6 Habitat or Ecosystem Conditions

Habitat is limited and only one population of KWS dace exists. The habitat remains in relatively good condition; however, habitat alterations by recreational users have occurred in the form of construction of a series of dams/pools near the springs and also by contamination of the springs and stream by soaps, shampoos, and detergents. Bathing, wading, and washing clothes in the Kendall Warm Springs area is currently prohibited, but some illegal activities have continued to occur, documented by issued citations. USFS should be commended for their dedication and commitment to protect this species and its habitat over the long-term.

2.4.1.7 Other

A number of natural predators of KWS dace are present in its habitat. Dragonfly nymphs prey on larvae and small juvenile KWS dace (Gryska and Hubert 1997). Other potential predators are dippers (*Cinclus mexicana*), Brewer's blackbirds (*Euphagus cyanocephalus*), great blue herons (*Ardea herodias*), and wandering garter snakes (*Thamnophis elegans vagrans*).

2.4.2 Five-Factor Analysis

The threats presented here are ranked according to the USFWS' "Draft Guidance for Conducting Threats Assessment under the ESA" (USFWS 2006a). A systematic examination of what is known about KWS dace life history, in the context of the five listing factors in the ESA was used to help identify threats. In order to better understand how any given threat actually affects the species, each identified threat was partitioned into ***stressors*** which actually impact or have the potential to impact individuals of the species. This helps to assess the magnitude of the impact, and the ***source(s)*** of the stressor which often provides insight into how to alleviate a threat. We used the threats assessment to evaluate each stressor for its ***scope, immediacy,*** and ***intensity,*** as a way of identifying the true magnitude of the potential threat to the target species. Using the threats assessment, we also characterized both the ***exposure*** of the target species to the stressors and the ***response*** of the species to the threat (see Table 2, Figure 9, Appendix B, and Appendix C).

TABLE 2.
Key to Threat Ranking

FACTORS:
A. The present or threatened destruction, modification, or curtailment of its habitat or range.
B. Overutilization for commercial, recreational, scientific, or educational purposes.
C. Disease or predation.
D. The inadequacy of existing regulatory mechanisms.
E. Other.
SCOPE (Geographic extent of threat factor occurrence):
1. Localized
2. Rangewide
IMMEDIACY (Timeframe of stressor):
1. Future
2. Imminent
3. Historic
INTENSITY (Strength of stressor):
1. Low
2. Moderate
3. High

EXPOSURE (Level of population exposed):

1. Insignificant
2. Small
3. Moderate
4. Significant
5. Very significant

RESPONSE:

1. Behavioral (startle, displace, etc.)
2. Basic need inhibited (feed/breed/shelter, possible reduction in growth rate, reproductive survival rate)
3. Mortality confirmed (or identifiable reduction in growth rate or survival)
4. Significant mortality (or significant reduction in growth rate, reproductive rate or survival)

OVERALL THREAT LEVEL:

1. Low (at this point in time, no action is needed)
2. Moderate (action is needed)
3. High (immediate action necessary)
4. Severe (immediate action essential for survival of the species)

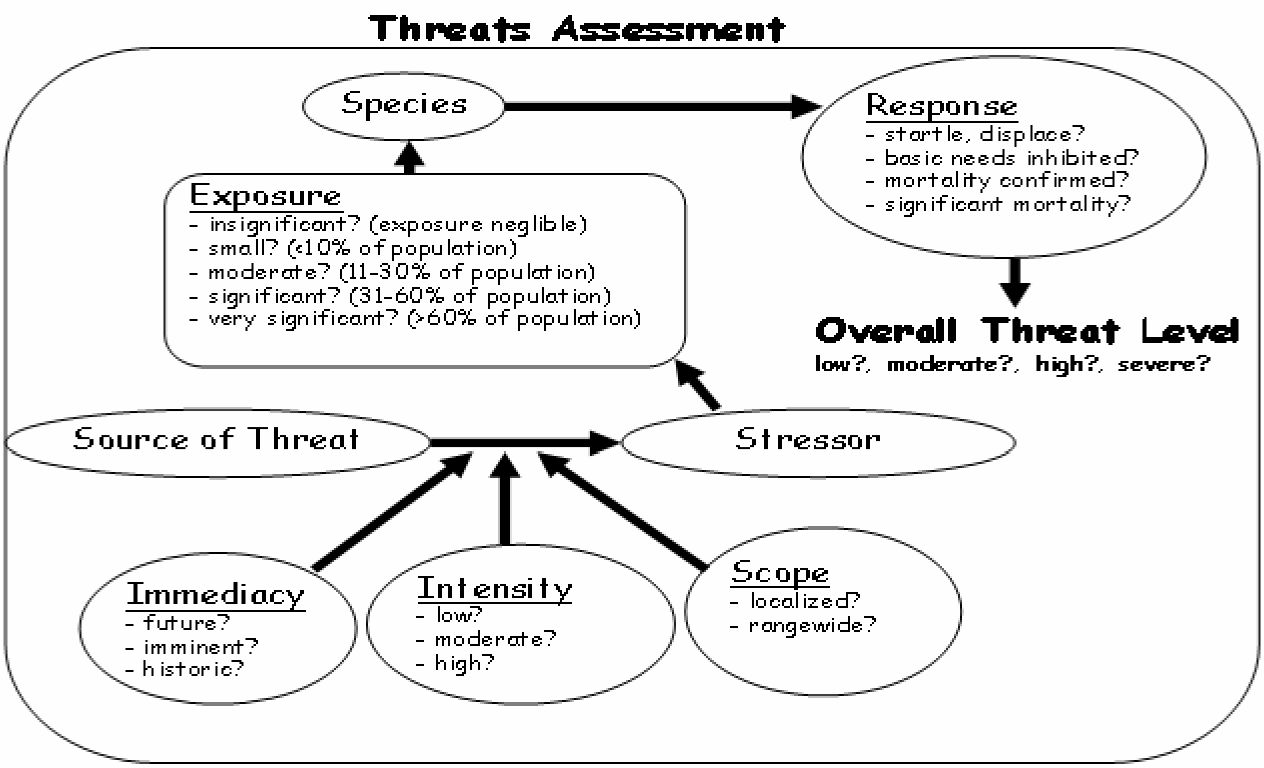


FIGURE 9.
Threats Assessment Model

2.4.2.1 The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

The following are threats that could or have resulted in the destruction, modification, or curtailment of the habitat or range of KWS dace (Table 3). Because there is only one population of KWS dace in one geographic area, any detrimental impacts which are negatively affecting the population are affecting the entire KWS dace population.

TABLE 3.
Threats to Habitat and Overall Threat Level Ranking

THREATS	OVERALL THREAT LEVEL			
	Low	Moderate	High	Severe
Bathing and the use of soaps in stream	X			
Research efforts	X			
Oil and gas development			X	
Excluding livestock from habitat		X		
Allowing livestock in habitat	X			
Increase in recreational use	X			
Reservoir construction	X			
Catastrophic wildfire	X			
Acid rain	X			
Herbicide/pesticide use	X			
Note: Appendix B provides additional detail on each factor including an evaluation of the stressors, their scope, immediacy, and intensity, sources of exposure, and the response of the species. These factors are considered collectively to justify the overall threat level indicated here.				

2.4.2.2 Bathing and Use of Soaps, Detergents, Sunscreen, and Bleaches in Species' Habitat

Historically, recreational mountain travelers would bathe in the warm springs. It is reported that individuals also would wash clothes in the warm water of the springs (Binns 1978). Swimming and bathing degraded water quality and/or modified the quantity of vegetation present; this is a rangewide threat. At one time, this threat may have been of moderate/high intensity resulting in mortality or inhibiting the basic needs of the species. The use of soaps, detergents, sunscreens, or bleaches in the Kendall Warm Springs has been prohibited since 1975 (Binns 1978) and signs posted onsite notify visitors of these prohibitions; therefore, the intensity of this threat is low at this time. The dace are currently undergoing insignificant exposure to this threat and, therefore, it is believed that the overall threat level for this threat is **low** at this time.

2.4.2.3 Deleterious Effects of Research Efforts

Research efforts could stress KWS dace population through reduction of habitat quantity and/or reduction in habitat quality. Researchers in their efforts to better understand the dace's habitat could enter the stream to analyze habitat and disturb the vegetation, the substrate and/or the invertebrates upon which the dace feed. The deleterious effects of research efforts are rangewide historic/future threats. The current exposure level for this threat is small. There are no current research efforts approved that could involve disruption or degradation of habitat. Currently permits are required by USFWS, USFS, and WGFD to perform research activities relating to KWS dace. The overall threat level for this threat is **low**. In the future, the potential deleterious effects (likely transitory and ephemeral) to the dace population from properly designed research efforts should be weighed against the benefits potentially-derived leading to better informed recovery and management actions.

2.4.2.4 Oil and Gas Development

Oil and gas development has not been known to stress KWS dace population in the past. It could potentially stress the dace population in the future through changing the spring water quantity (e.g., drying up the spring or decreasing flow) or water quality (e.g., altering temperature regime). Although Mattson (1998) estimated the potential recharge area of the spring to be an area 21,270 ac (8,593 ha) in size, the exact recharge area of the spring is not known with certainty and could extend across multiple watersheds. Oil and gas development is a potential future threat. If this threat does materialize, the exposure level would be very significant as 100% of the population would potentially be exposed. Significant mortality and possible extinction of the species could be realized within a very short time. Given the current, planned, and potential increase in oil and gas development in Sublette County, Wyoming, and the potential high intensity impacts to the world's only population of KWS dace, the overall threat level for oil and gas development is **high**.

USFS could authorize the Bureau of Land Management (BLM) to lease oil and gas development opportunities in the Kendall Warm Springs area in the future. If leasing does occur, this could result in construction and operation of new well locations, upgrading of existing roads and construction of new roads, pipelines, compressor stations, gas processing facilities, and evaporative ponds. Such development in the upper Green River watershed may impact crucial areas of KWS dace habitat and potential spring recharge areas. However, such activity also would be subject to section 7 consultation under the ESA and impacts potentially resulting from this activity could be minimized as a result.

The Mineral Leasing Act of 1920 provides that all public lands are open to oil and gas leasing unless a specific order has been issued to close an area. At present, with no protective measures in place, Federal land management agencies could authorize the development of oil and gas exploration and development activities within the potential recharge zone of the Kendall Warm Springs. The withdrawal of 160 ac (64.75 ha) around Kendall Warm Springs from mineral entry (27 FR 8830, August 28, 1962) only applies to "locatable" minerals such as gold, silver, and precious metals and not to "leaseable" minerals (oil and gas) or "salable" minerals (gravel, cobblestone, sand, etc.).

Interest in oil and gas exploration and development on the Bridger-Teton National Forest has prompted evaluations of all potential impacts of USFS activities to the habitat of KWS dace. In response to an increased interest in oil and gas drilling, Mattson (1998) conducted a hydrogeologic evaluation of the area surrounding the Kendall Warm Springs. Mattson (1998) recommended that in order to protect KWS dace from oil and gas development, a number of conservation measures and potential drilling restrictions should be implemented in the potential recharge area of the Kendall Warm Springs.

The 1990 Bridger-Teton National Forest LRMP identified these areas as being administratively available for oil and gas leasing (USFS 1990). The USFS 2000 draft Environmental Impact Statement (EIS) describes a proposal to authorize leasing activities surrounding the habitat of KWS dace (USFS 2000). However, the LRMP did not make site-specific decisions concerning the leasing of these available lands. The Forest Supervisor of the Bridger-Teton National Forest did decide to not pursue oil and gas leasing in the areas analyzed in the draft EIS (USFS 2000) due to overwhelming opposition from the public (USFS 2003). No final EIS or Record of Decision has been developed or completed over the draft proposal.

The draft EIS published by USFS (2000) estimated that, over the approximately 369,900 ac (149,698 ha) evaluated for potential oil and gas leasing activities, 30 to 128 wells could be expected to be drilled in the upper Green River area (with associated facilities such as roads, pipelines, and power lines), if leasing were allowed. This scenario was developed using historical oil and gas development information from USGS, other known geologic information, and interpretation of information by BLM and USFS geologists, as well as input from the oil and gas industry.

Alternatives and stipulations for development evaluated in the draft EIS included--(1) a no development alternative, (2) allowing leasing in all four management areas, (3) using No-Surface Occupancy (NSO) stipulations in all USFS roadless areas and areas where sensitive soils exists, (4) making unavailable the 21,270 ac (8,593 ha) of potential recharge area of KWS dace as evaluated by Mattson (1998), and (5) limiting the number of well pads to one per 160 ac (64.75 ha).

Construction and operation of drill sites, if permitted, could result in the potential contamination, depletion, or change in water quality of the aquifer which supplies the Kendall Warm Springs. Such an irretrievable commitment of that water supply and recharge zone for Kendall Warm Springs could cause the extinction of KWS dace.

If oil and gas activities are authorized according to the USFS draft EIS (USFS 2000), the following project aspects would be expected to occur:

1) All roads built or upgraded to access leases or facilitate field developments would be open to public traffic, except where administrative closures are in place.

2) With field development, access roads would be plowed in the winter where and when possible, or would be utilized by over-the-snow vehicles.

3) An area of 1,200 ac (485.6 ha) around Kendall Warm Springs would be recommended for withdrawal from locatable mineral entry as well as would carry a NSO Stipulation for leaseable minerals.

4) Acres of disturbance would be 3 ac for each well pad, and 1 mile of road and 1 mile of pipeline for each well, both located in the same corridor which would be 60 ft (18.3 m) wide.

5) During development (drilling), it should be assumed that the area would receive high occupancy with high traffic use for approximately 90 days. However, this activity could occur for as much as 180 days.

6) During production, it should be assumed that one visit per well by pick-up truck would occur per day. Most emissions from oil and gas activities would be concentrated during the time period in which each well is being drilled and completed. This could extend from 3 to 6 months (USFS 2000).

During the production phase (which could last 15 years or longer), dust from roads and pads would be substantially less than during the exploration and development phase, given the same amounts of road construction. Pad sizes are typically smaller for production facilities, and vehicular use rates are much less. A producing field containing tank facilities, gas separation facilities, gas powered combustion compressor engines, diesel pumps, and other related equipment would produce odors due to the venting of gasses and other emissions. In the production phase, air pollutants such as carbon monoxide, hydrocarbons, nitrous oxides, sulfur dioxide, and hydrogen sulfide can be produced. The U.S. Environmental Protection Agency states that a single well can produce in the vicinity of 250 tons (227 metric tons) of pollutants per year. These pollutants can be injected in the environment during disposal of liquid waste and unwanted gases by burning of waste products, and by fugitive loss of gases from storage tanks and other facilities. Accidental explosions, fires, blowouts, oil spills, and leaks cause potentially serious pollution problems as well (USFS 2000).

The management area that contains KWS dace and the springs' potential recharge area is predicted to have one of the highest potentials for projected oil and gas development as analyzed by the draft EIS (USFS 2000). Having such a high potential for oil and gas development increases the likelihood that there will be renewed interest in oil and gas drilling in the area. Fracturing of the substrata supporting the hydrologic conditions of the Kendall Warm Springs could occur, unless proper conservation measures or lease stipulations are implemented.

If plans for drilling in the area are pursued, the overall threat level for this threat could quickly become severe with immediate action being essential for survival of KWS dace. Conservation measures to minimize this threat include making the 21,270 ac (8,593 ha) of the springs' potential recharge area "administratively unavailable" for oil and gas leasing (Figure 10) (Mattson 1998). To date, this proposed conservation measure has not been implemented by the relevant agencies.

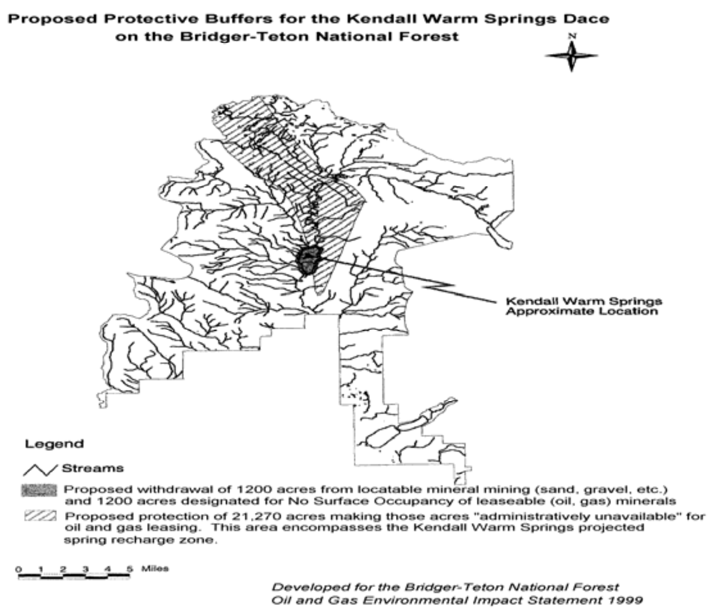


FIGURE 10.
Proposed Buffers for Kendall Warm Springs

2.4.2.4.1 Livestock

Impacts to KWS dace (both beneficial and detrimental) could arise from-- (1) absence of livestock from the Kendall Warm Springs as well as (2) the presence of livestock in the stream area.

2.4.2.4.1.1 Absence of Livestock in Habitat

This threat may affect KWS dace population through (1) reduction of "nursery areas" for dace fry (due to livestock not physically creating these areas from wading and wallowing in the stream and stream-side), (2) increased narrowing of the stream channel, (3) reduction of nutrients into the spring (from cattle manure) thereby changing the stream's productivity (plant community biomass, macroinvertebrate quantity, dace abundance), and (4) increased growth of streamside plant community (later successional stages) due to exclusion of grazing livestock.

This is a rangewide threat that is affecting the population currently as the livestock are currently being excluded from the dace habitat and 160 ac (64.75 ha) surrounding it. USFS constructed a fence and excluded livestock from Kendall Warm Springs in 1969. During recent years, USFS has observed a noticeable decrease in backwater, “fry-nursery-area-type” habitat and narrowing of the stream channel—possibly as a result of the exclusion of livestock from the Kendall Warm Springs area. To date this modification of habitat for the dace has not been measured or quantified. This is a moderate intensity threat which would be expected to affect 100% of the dace population. This threat may deprive the dace of their basic needs to survive such as areas needed for feeding, breeding, and sheltering. A possible decrease in the population could result from a decrease in available habitat. The overall threat level for this threat is **moderate**.

At this point, it is uncertain what conditions characterized the Kendall Warm Springs stream, prior to European settlement of the area. It is possible that ungulates such as bison or elk grazed the area periodically and maintained the backwater “fry-nursery-areas” during early historic “pre-settlement” times. There has been some observations that elk and moose are not excluded by the livestock exclusion fence and do still create some backwater areas (hoof prints) which are used by dace fry. It is possible that the “narrowing” of the stream channel as observed by USFS represents a returning of the stream to its “historic or pristine” condition originally present in the absence of agricultural livestock grazing. Studies to measure any change in habitat over time should be undertaken to better understand this potential threat.

Other theories for narrowing of the stream channel also should be developed and analyzed. For example, narrowing of the stream channel also may have resulted from the removal of the two 24–in. (0.6-m) road culverts (which may have acted as grade control structures) and their replacement with a 30-ft (9.1-m) bridge (USFS 1997). Narrowing of the stream channel also may be influenced by below normal precipitation within the watershed.

2.4.2.4.1.2 Presence of Livestock in Habitat

If allowed to enter Kendall Warm Springs, livestock could affect the dace population through siltation of habitat and toxification of habitat. Livestock wading in the stream could cause some disturbance of the gravel and rock substrate of the stream bottom and allow some sediments to become suspended in the water or deposited in interstitial spaces that are critical for invertebrate production. Since the stream is relatively short (984 ft [300 m] long) with a fairly rapid discharge of 6 to 8 cfs (0.17 to 0.23 cms), it would not be expected that much effect would be observed from the disruption of the stream bottom caused by only a few head of livestock present over a short time period. It would be expected that most suspended sediment would be flushed from the stream, over the falls, and into the Green River within a relatively short time. Livestock use of the stream is known to increase the quantity of toxic chemical (e.g., nitrates, ammonia) levels from manure and urination of the large grazing animals in the stream. The extent of deleterious effects from this threat would depend on the number of livestock present and the duration of their stay. A fence regularly maintained by USFS excludes livestock from 160 ac (64.75 ha) immediately adjacent to the stream. Since this is a historic threat that has been minimized by excluding the livestock from KWS dace habitat, we rank the overall threat level for this threat as **low**.

Livestock Conclusion

The relative impacts of livestock presence vs. livestock absence have not been thoroughly evaluated using empirical studies. A more holistic evaluation of these stressors may lead to better management of KWS dace population in the future. Ultimately, management for the potential impacts of livestock could be addressed by adaptive management techniques to maximize beneficial effects to the species while minimizing deleterious effects.

2.4.2.4.2 Increased Recreational Use of Area

The increase in recreational use of the area could lead to an increase in incidents of trespass and wading/bathing in Kendall Warm Springs. Dace habitat could be modified by bathers seeking to increase the depth of the stream by excavating areas and constructing rock dams. People wading in the stream also could alter vegetation and stream beds. This is a potential rangewide threat that would be expected to have a low intensity. Habitat modifications or trespass into Kendall Warm Springs by bathers has not recently been documented. For these reasons, we rank the overall threat level for this threat as **low**.

2.4.2.4.3 Reservoir Construction/Water Impoundments in Upper Green River Watershed

The scope of this threat is rangewide. This is potentially a high intensity threat. An impoundment in the watershed which supplies the recharge water for the Kendall Warm Springs could potentially change both the quantity and quality of the water in Kendall Warm Springs. Although unlikely at this time, a major water impoundment could completely inundate the Kendall Warm Springs as has occurred to other thermal springs in Wyoming (e.g., Alcova Hot Springs currently inundated by Alcova Reservoir). If water quality or quantity of the Kendall Warm Springs is changed, the dace would likely suffer significant mortality and potential extinction.

Three potential reservoir sites on the upper Green River (Kendall, Wells, and Gannett) were mentioned in potential reservoir impoundment plans by a Wyoming Water Resources Research Institute study done in the late 1960s (Binns 1972; N. A. Binns, WGFD (retired), pers. comm., June 15, 2007). Plans developed at that time indicated that a dam at the Kendall site could impound as much as 1 million acre-feet (1,233 million cubic meters), which would most certainly inundate Kendall Warm Springs and the 984 ft (300 m) of stream habitat occupied by KWS dace. On May 17, 1968, an application was filed to the Wyoming State Engineer for a 608,600 acre-foot (750,403,800 cubic meter) capacity Kendall Reservoir (N.A. Binns, WGFD (retired), pers. comm., June 15, 2007). Public hearings on the proposed Kendall Dam were held in Pinedale and Green River City, where the proposal encountered considerable public resistance and the proposal was later shelved (N.A. Binns, WGFD (retired), pers. comm., June 15, 2007).

Recently, there has been some interest in developing water storage facilities in the Green River basin, although no further action has been taken on this, to date (M. Besson, Wyoming Water Commission, pers. comm., April 3, 2007). There are currently no known plans to impound any waters in the Upper Green River watershed. Therefore, we believe KWS dace have a negligible, insignificant exposure to this threat at this time and we rank the overall threat level as **low**. If plans are developed for reservoir construction or water impoundments in the area, then the overall threat level could quickly change to one with severe effects.

2.4.2.4.4 Catastrophic Wildfire

The threat of catastrophic wildfire could represent a rangewide threat to KWS dace. This is a future threat that could be of high intensity. Catastrophic wildfire in the forested area which recharges the Kendall Warm Springs could cause hydrologic or thermal changes to the spring. This was seen lower in the watershed in the Surprise Lake area in Sublette County. There, a wildfire burned areas of the drainage and changed the temperature regime of the major spawning tributary of golden trout in the lake. The tributary was no longer suitable for golden trout spawning and the natural recruitment of that population declined (S. Roth, USFWS, pers. comm., February 15, 2007).

Depending on the severity and intensity of a wildfire, burning of the forest could cause--(1) increased runoff rates from the surrounding mountainsides, (2) decreased infiltration of precipitation into the Kendall Warm Springs recharge zone, and (3) siltation of the spring water of Kendall Warm Springs. KWS dace habitat is located in a sagebrush/grass vegetation type. Forested areas occur in the upper slopes of the recharge area for the Kendall Warm Springs. Currently, the forest surrounding the Kendall Warm Springs is predominantly lodgepole pine that is dying out due to pine bark beetle infestations. Fuel loading is typical for that region (5 to 20 tons/ac [11.2 to 44.8 metric tons/ha). The potential recharge area for the Kendall Warm Springs is large (21,270 ac [8,593 ha]) and the potential for a wildfire to occur there is moderate. Given the high public use of that area, suppression of any wildfires occurring there would be attempted at the earliest stages (P. Huda, USFS, pers. comm., January 22, 2007). As catastrophic wildfires occurring in that area are expected to be controlled by suppression efforts before they could potentially have deleterious effects to the Kendall Warm Springs ecosystem, the overall threat level for this threat is **low** (for discussion of effects from fire suppression/flame retardants, see Toxins). Furthermore, wildfire is a natural event in the ecosystem surrounding the Kendall Warm Springs. It is likely that large fires have historically burned through the area on a periodic basis.

2.4.2.4.5 Acid Rain

An increase of pollutants in the air could lead to a change in the pH of the rain water/snowmelt which recharges the Kendall Warm Springs. A change in pH caused by acid rain could be a threat of regional scope affecting multiple States. It is unknown if effects from this threat are currently affecting the KWS dace population. Given the increase in industrialization of Sublette County, Wyoming, and the concomitant concern with decreasing air quality, it is conceivable that acid rain could alter the water chemistry of Kendall Warm Springs. Prevailing winds may transport pollutants for industrialized regions located to the west. It is anticipated that the acid rain, if it occurred in the KWS dace area, would be of low intensity. Also, the spring water is alkaline and emits from a limestone formation supplying calcium anions to the spring water (Binns 1978). Therefore, the spring may be fairly insulated from any threat from acid rain. Presently, no evidence of acid rain affecting the spring is known so the overall threat level from this threat is currently **low**.

2.4.2.4.6 Herbicide/Pesticide Use

The use of herbicides for weed control could affect KWS dace habitat in the near future. Some invasive weed species are present in the immediate vicinity of Kendall Warm Springs. Treatment of these with herbicides, if not appropriately conducted, could lead to localized contamination of dace's habitat, a decrease in aquatic vegetation of the habitat, and a reduction in invertebrate numbers which could lead to decreased habitat suitability for the dace. Even a brief exposure to a weak solution could prove lethal to the dace. A weak solution in the stream also could damage or destroy algae and phytoplankton, thus altering the basic productivity of the stream and degrading the food chain upon which the dace depend. Similarly, pesticide use, if not conducted properly, could be lethal to the dace or damage or destroy aquatic benthic invertebrates, as well as zooplankton, upon which the dace feed.

Because potential applications of herbicides or other pesticides near the dace's habitat are under the control of USFS and section 7 consultation requirements apply to this activity, we have ranked the overall threat level of this threat as **low**. The ESA, requires USFS to consult with USFWS prior to activities which they determine "may affect" a listed species. It is assumed that a well-planned protocol to minimize or eliminate adverse effects to the dace would be developed during section 7 consultation between USFS and USFWS prior to the use of either herbicides or pesticides near the dace's habitat.

2.4.2.5 Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

The following are threats caused by the overutilization of KWS dace for commercial, recreational, scientific, or educational purposes (Table 4).

TABLE 4.
Threats Related to Overutilization of the Species and Overall Threat Level Ranking

THREATS	OVERALL THREAT LEVEL			
	Low	Moderate	High	Severe
Personal aquaria/commercial trade purposes	X			
Deleterious effects of research efforts	X			
Use of KWS dace as bait fish	X			
Note: Appendix B provides additional detail on each factor including an evaluation of the stressors, their scope, immediacy, and intensity, sources of exposure, and the response of the species. These factors are considered collectively to justify the overall threat level indicated here.				

2.4.2.5.1 Illegal Taking of Dace

Illegal taking of the dace for home aquaria or for other commercial trade purposes could cause reduction of KWS dace numbers. To date, this has not been an issue since no illegal taking of the dace has been documented. If illegal take has occurred, it appears that the population has not been impacted. However, in other parts of the world, other rare and endangered species have been exploited for food, medicinal, or ornamental properties. Some are sold locally or internationally to rare species collectors pushing those species closer to extinction. Potential exists for similar activity to occur to KWS dace. Any illegal collections of the dace would be presumed to be of low intensity with a small portion of the population exposed to such efforts. As recreational use of the Green River area increases, this threat may increase in intensity. For these reasons, we rank the overall threat level for this threat as **low**.

2.4.2.5.2 Deleterious Effects of Research Efforts

By visual observations from the stream-side, the population appears robust. The habitat appears to be completely occupied and the fish breed year-round. Because there are some unknown aspects of the dace's biology, there is a high probability that some KWS dace or their invertebrate prey will be utilized for scientific purposes in the future. Some research efforts may include attempts at captive rearing or population monitoring. Successful captive rearing or establishment of refugia populations will depend on learning the breeding requirements of this species in captivity. If this is undertaken, it will require field capture of individuals and acclimatization to a laboratory setting. It is likely that some individuals will die from trapping mortality or disease. It is unlikely that individuals removed from the KWS dace population for captive rearing studies would be returned to Kendall Warm Springs because doing so would risk the introduction of disease contracted in the laboratory to the Kendall Warm Springs population. To date, accurate estimates of population size of KWS dace or its prey base have not been attempted. Mark-recapture experiments to estimate population size, if they occur in the future, could stress fish causing mortality to some dace. Currently, because of the dace's listed status, a recovery permit would be required under section 10 of the ESA and the effects to the species would have to be evaluated prior to issuance of a permit to conduct research. Because any research efforts to study the dace would not be approved unless they were of low threat intensity and/or constituted insignificant exposure to the population as a whole, we rank the overall threat level for this threat as **low**.

2.4.2.5.3 Use of Kendall Warm Springs Dace as Bait Fish

The use of KWS dace as bait fish is a historical threat with very little potential to occur in the future. It is uncertain to what extent this activity occurred in the past. The WGFD prohibited the use of KWS dace as bait beginning in the 1960s. This is a rangewide threat of high intensity with an unknown past exposure level. Depending on the extent of its capture by anglers, anywhere from a small part of the population to a very significant part of the population may have been impacted. Death would be assumed to be the response of KWS dace used as bait fish; and if they were released alive, it would be unlikely that they would be returned to Kendall Warm Springs.

As there currently are prohibitions against using KWS dace as bait and no exposure of the population to this threat is anticipated in the future, we rank the overall threat level for this threat as **low**.

2.4.2.6 Disease or Predation

The following are threats caused by disease or predation (Table 5).

TABLE 5.
Disease or Predation-related Threats and Overall Threat Level Ranking

THREATS	OVERALL THREAT LEVEL			
	Low	Moderate	High	Severe
Disease or predation stemming from research efforts	X			
Disease or predation of dace from introduction of exotics			X	

Note: Appendix B provides additional detail on each factor including an evaluation of the stressors, their scope, immediacy, and intensity, sources of exposure, and the response of the species. These factors are considered collectively to justify the overall threat level indicated here.

2.4.2.6.1 Disease Stemming From Research Efforts

Deleterious effects from disease could be realized as a result of research efforts. Equipment or waders used in habitat during dace population assessment could serve as pathways for the introduction of disease into the population. This is a rangewide threat which could occur under current management procedures. Precautions are now taken to minimize the risks of disease being introduced into the KWS dace population. Current research protocol calls for all equipment and waders used for research efforts in the habitat of KWS dace be disinfected with a 10% bleach solution before entering the habitat.

If disease were to be introduced into the population, potentially 100% of the KWS dace population could be affected. Depending on the type of disease introduced, the response from individuals could range from behavioral to significant mortality or extinction. At this time, the overall threat level from this activity is **low** because action is taken by researchers to avoid the introduction of disease into the population.

2.4.2.6.2 Disease or Predation of Dace From Introduction of Exotics

Historically, disease or predation has not been an issue as no introduced species or diseases have been documented in the habitat of KWS dace. Potential exists for illegal introduction of warm-water or tropical fishes into the habitat of this species. Introduced fish diseases or predators to the Kendall Warm Springs could have devastating effects on the KWS dace population potentially affecting 100% of the population. Introduced predatory fishes could easily decimate the dace population and lead to extinction of the species. The overall level for this threat is high and immediate action is necessary. Many examples exist of other fish restricted to one location that have been decimated or gone extinct at least partially caused by exotic species introductions. For further detail regarding the potential effects of introduced species on the Kendall Warm Springs ecosystem, see discussion below.

The Wyoming Game and Fish Commission currently prohibits the introduction of nonnative fishes to Kendall Warm Springs or any waters of the State; but illegal introductions of nonnative fish species still occur (Rahel 2000). No additional conservation measures or precautions prevent the illegal introduction of nonnatives to Kendall Warm Springs. Because this is a high intensity threat with potential for very significant exposure of the species potentially causing significant mortality or extinction of the species, we rank the overall threat level for this threat as **high**.

2.4.2.7 Inadequacy of Existing Regulatory Mechanisms

Prohibitions currently exist against--(1) wading, bathing, or the use of soaps or detergents for washing clothes in the Kendall Warm Springs and associated stream habitat, (2) livestock use of the stream for watering purposes, (3) introductions of exotic species into the habitat of the dace, (4) mining or staking locatable mineral claims in a 160-ac (64.75-ha) area surrounding the Kendall Warm Springs habitat, (5) the use of Kendall Warm Springs dace as baitfish (see WGFD 2007a), and (6) fishing in the Kendall Warm Springs area (WGFD 2007b) (see Appendix C). These existing regulatory mechanisms are important and help protect the species.

Although prohibited since 1975, some wading and bathing in the spring could still occur. USFS conducted a population survey of KWS dace in 2005. During that survey, four of the traps used to capture the dace were tampered with. One trap disappeared completely during a day set (was the most visible from the road), two traps were partially stepped on (presumably by a small, hoofed animal), and one was removed from the stream and placed atop an algae mat. Five dace were found dead in that trap (see USFS 2006).

Livestock are currently prohibited from entering Kendall Warm Springs and an exclusion fence is regularly maintained by USFS. These measures have been effective at excluding livestock from Kendall Warm Springs. However, livestock have occasionally gained access to the springs for watering. Those situations involved--(1) downed portions of the exclusion fence, (2) low water levels in the Green River due to drought conditions allowing livestock to swim across the Green River, or (3) low water levels in the Green River allowing cattle to walk or wade around the portion of the fence which extends to the edge of the Green River. The impacts to the habitat resulting from such situations should be more thoroughly evaluated by empirical studies to determine if periodic entry of cattle into the stream should be used to maintain or expand the dace's habitat in the absence of historically occurring large ungulates (e.g., bison).

To date, no exotic fish species are known to have been introduced into Kendall Warm Springs. Other thermal springs throughout North America have regularly received introductions of nonnative species (see section below), making additional precautions or regulatory mechanisms appropriate. Vigilant enforcement of such restrictions on illegal exotic species introductions may be highly difficult because this crime may not be discovered until long after it is committed.

Although the area surrounding Kendall Warm Springs has been withdrawn from locatable mineral entry (27 FR 8830, August 28, 1962), the possibility still remains that fluid mineral mining (oil and gas development) or salable mineral mining (e.g., pea gravel, gravel, cobblestone) could be proposed and conducted in the Kendall Warm Springs recharge zone which has been estimated to be 21,270 ac in size (Mattson 1998).

A Kendall Warm Springs Biological Unit Management Plan was approved by USFS in 1978. The management objectives of that plan were to--(1) maintain or improve the quality and quantity of the presently occupied habitat and (2) to perpetuate a viable population level of dace. The area designated by this plan encompasses 160 ac (64.75 ha). This was the same acreage which was withdrawn from mineral entry under EO-10355 in 1962, fenced to provide habitat protections in 1969, and identified as "essential habitat" for the dace in 1977. Boundaries include most of the small watershed and adjacent terrestrial communities which surrounds and directly affect the spring and stream section.

The Bridger-Teton National Forest LRMP, approved in 1990, covers the known population of dace (USFS 1990). The LRMP contains general standards and guidelines for the maintenance and enhancement of KWS dace habitat. More specific conservation measures relevant to KWS dace would be helpful for its management and conservation.

Lack of regulatory mechanisms is a rangewide threat with a moderate intensity as opportunities to more effectively regulate activities affecting the species may be missed. Because we rank the intensity level of this threat as moderate and the exposure level as moderate/significant, we assign the overall level of threat as **moderate** at this time. Although many regulatory mechanisms are currently in place independent of the ESA and are fairly effective at controlling some of the more deleterious threats that could potentially affect the dace, there are still other regulations which could be added or improved for further protection of the dace (see Table 8).

2.4.2.7 Other

The following are other threats to the dace which are not fully analyzed in the preceding sections (Table 6).

TABLE 6.
Other Threats and Overall Threat Level Ranking

THREATS	OVERALL THREAT LEVEL			
	Low	Moderate	High	Severe
Other effects stemming from introduction of exotics			X	
Activities of vandalism		X		
Climate change		X		
Lack of scientific knowledge/monitoring		X		
Threats associated with small population size		X		
Toxins			X	
Other natural events	X			

Note: Appendix B provides additional detail on each factor including an evaluation of the stressors, their scope, immediacy, and intensity, sources of exposure, and the response of the species. These factors are considered collectively to justify the overall threat level indicated here.

2.4.2.7.1 Other Effects Stemming From Introduction of Exotics

The introduction of nonnative fish or other aquatic species to the spring could upset the ecological balance currently present in the spring ecosystem thereby potentially impacting KWS dace or potential hybridization could destroy the genetic integrity of this unique subspecies (Echelle and Connor 1989; Dowling and Childs 1992). Predation, competition for food, shelter, breeding sites, or competition for other resources could occur as a result of the introduction of nonnative species.

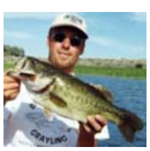
Small populations of other dace species occurring in thermal springs in other areas of North America have been severely impacted, been partially extirpated, or become extinct, because of the introduction of nonnative species (see Table 7, Figures 11, 12) which were able to survive in the warm waters which those dace historically inhabited (Deacon et al. 1964; McAllister 1969; Lanteigne 1987; Renaud and McAllister 1988; Nico 2006; Nico and Fuller 2006; USFWS 2006b).

Convict cichlid

Goldfish

Black bullhead

Green swordtail



Largemouth bass

Mosquitofish

New Zealand Mudsnail

Tiger barb

Blue gourami

Angelfish

Common carp

Siamese fighting fish

FIGURE 11.
Exotic Species Introduced Into Thermal Springs Inhabited by Other Dace Species in North America

TABLE 7.
Species of Dace, Their Status, Location, and Exotic Species Introduced Into Their Habitats

NATIVE SPECIES	STATUS	LOCATION	EXOTIC SPECIES INTRODUCED INTO HABITAT
Moapa dace (*Moapa coriacea*)	Federally Endangered	Moapa River and associated thermal springs in Clark Co., Nevada	Common carp (*Cyprinus carpio*)
			Shortfin molly (*Poecilia mexicana*)
			Channel catfish (*Ictalurus punctatus*)
			Largemouth bass (*Micropterus salmoides*)
			Fathead minnow (*Pimephales promelas*)
			Black bullhead (*Ameiurus melas*)
			Tilapia (*Oreochromis aurea*)
			Mosquitofish (*Gambusia affinis*)
			Fish tapeworm (*Bothriocephalus acheilognathi*)
			Fish nematode (*Contracaecum* spp.)
			Anchor worm copepods (*Lernaea* spp.)
Speckled dace (*Rhinichthys osculus*)	Common	Kelly Warm Springs, Wyoming	Convict cichlid (*Cichlasoma nigrofasciatum*)
			Guppy (*Poecilia reticulata*)
	Extirpated	Near Lake Mead, Nevada	Convict cichlid (*Cichlasoma nigrofasciatum*)
Kendall Warm Springs dace (*Rhinichthys osculus thermalis*)	Federally Endangered	Kendall Warm Springs, Wyoming	None
Banff longnose dace (*Rhinichthys cataractae smithi*)	Extinct	Thermal spring in Banff National Park, Alberta, Canada	Mosquitofish (*Gambusia affinis*)
			Green swordtail (*Xiphophorus helleri*)
			Convict cichlid (*Cichlasoma nigrofasciatum*)
			Sailfin molly (*Poecilia latipinna*)
			Jewelfish (*Hemichromis bimaculatus*)
			Angelfish (*Pterophyllum scalare*)
			Blue gourami (*Trichogaster trichopterus*)
			Siamese fighting fish (*Betta splendens*)
			Brook charr (*Salvelinus fontinalis*)
Desert dace (*Eremichthys acros*)	Federally Threatened	Thermal springs in Humboldt Co., Nevada	Lahonton redside (*Richardsonius egregious*)
			Largemouth bass (*Micropterus salmoides*)
			Channel catfish (*Ictalurus punctatus*)
			Goldfish (*Carassius auratus*)
			Anchor worm copepods (*Lernaea* spp.)
Ash Meadows speckled dace (*Rhinichthys osculus nevadensis*)	Federally Endangered	Thermal springs in Ash Meadows, Nevada	Mosquitofish (*Gambusia affinis*)
			Sailfin molly (*Poecilia latipinna*)
			Largemouth bass (*Micropterus salmoides*)
			Crayfish (*Procambarus* spp.)
			Bullfrog (*Rana catesbeiana*)
			Arawana (*Osteoglossum bicirchosum*)
			Black bullhead (*Ameiurus melas*)

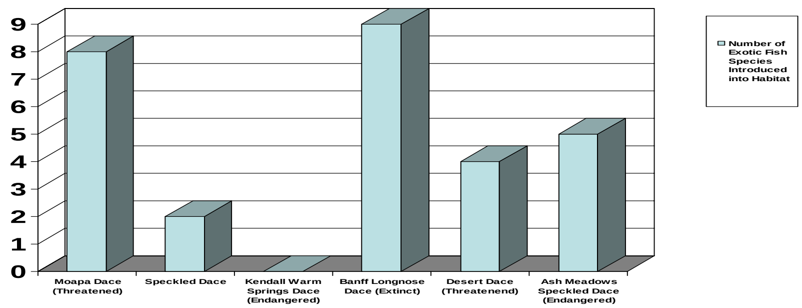


FIGURE 12.

Comparison of Number of Exotic Fish Species Introduced Into Thermal Springs Inhabited by Dace in North America

The nearest thermal spring to Kendall Warm Springs where there are documented cases of introduced nonnative species is Kelly Warm Springs located to the northwest in Teton County, Wyoming. In Kelly Warm Springs, which is inhabited by the more common speckled dace (*Rhinichthys osculus*), there have been introductions of guppies (*Poecilia reticulata*) and convict cichlids (*Cichlasoma nigrofasciatum*) (Nico 2006; Nico and Fuller 2006). Convict cichlids pose a threat to small native fish because of their predatory nature. Guppies pose a threat to native fish because not only are they a hardy, prolific competitor, but they also can carry exotic trematode parasites (Nico 2006). They also are effective predators of larval fish (e.g., potentially KWS dace fry). According to Deacon et al. (1964), convict cichlids, in combination with other nonnative fishes, apparently caused the decline and extermination of a population of speckled dace (*R. osculus*) near Lake Mead, Nevada.

The speckled dace (*R. osculus*) occurs in the Green River adjacent to Kendall Warm Springs. If speckled dace were able to persist in the thermal environment of the Kendall Warm Springs stream, then an introduction of the speckled dace, either deliberate or without malicious intent, could have significant implications for the genetic integrity of the KWS dace population through intraspecific hybridization. Similar effects have occurred to the Pecos pupfish (*Cyprinodon pecosensis*) (Echelle and Connor 1989), the Apache trout (*Oncorhynchus apache*), and the Gila trout (*O. gilae*) (Dowling and Childs 1992) through the introduction of allopatric conspecifics. We know of no studies involving KWS dace undertaken to identify whether or not incidents of intraspecific hybridization have occurred in the past. Though we rank the exposure level of this threat as currently small, the intensity level could be high given the potentially significant implications for the preservation of genetic integrity of this unique subspecies and because the ability to detect genetic contamination by speckled dace is very low given the size of the occupied habitat and lack of genetic monitoring currently employed.

The potential upset of the ecological balance of the Kendall Warm Springs ecosystem by the introduction of one or more nonnative species or the potential loss of the genetic integrity of KWS dace through introduction of other *Rhinichthys* species if it occurred would be a rangewide threat. Any introduction of nonnative species could presumably affect 100% of the KWS dace population since the dace is only found in one locality. The KWS dace population could suffer significant mortality or other deleterious effects.

Enforcement of regulations and laws associated with illegal exotic species introductions and apprehension of perpetrators, after the fact, also are decidedly difficult. Because this threat could materialize relatively easily with high intensity inhibiting the basic needs of the species over the species' entire range, this threat has an overall threat level rank of **high.** Action should be undertaken to lessen the potential impacts associated with this threat. Perhaps improved interpretive signs would be helpful. Signs could warn of the consequences of disturbing an endangered species or its habitat and stress the fact that the area is regularly patrolled by USFS enforcement personnel. Signs also could label the area as a "research area" which may serve as a suitable deterrent without provoking vandalism.

2.4.2.7.2 Activities of Vandalism

Potential exists for deliberate poisoning of KWS dace or the purposeful introduction of deleterious nonnative species into its habitat. Poisoning could occur through the application of pesticide or other contaminant(s). Because it is only found in one location, the entire population of KWS dace could be eliminated by such an action. To date, there is no indication that anyone or any group would attempt to vandalize the KWS dace population. This is a rangewide threat which has the potential to affect 100% of the population and since only one population of KWS dace exists, this could lead to its extinction. We rank the intensity of this threat as high, but with only a small exposure to the population because we do not believe that individuals are likely to vandalize the dace population in the near future. For these reasons, we give this threat an overall threat level of **moderate.**

2.4.2.7.3 Climate Change

Scientific evidence currently indicates that the increase in greenhouse gases in the Earth's atmosphere caused by the burning of fossil fuels such as coal, oil, and natural gas are having a worldwide effect on the Earth's climate. Worldwide temperatures have risen over the past century and that trend is expected to continue. With worldwide warming, the polar ice caps and montane glaciers are melting at accelerated rates and below normal precipitation is occurring in many areas (Barry and Seimon 2000; Hall and Fagre 2003).

The magnitude of warming in the northern Rocky Mountains has been particularly great, as indicated by an 8-day advance in the appearance of spring phenological indicators since the 1930s (Cayan et al. 2001). The hydrologic regime in the northern Rockies also has changed with global climate change and is projected to change further (Bartlein et al. 1997; Cayan et al. 2001; Stewart et al. 2004). Under global climate change scenarios, the mountainous areas of northwest Wyoming may eventually experience milder, wetter winters and warmer, drier summers (Bartlein et al. 1997). Additionally, the pattern of snowmelt runoff also may change, with a reduction in spring snowmelt (Cayan et al. 2001) and an earlier peak runoff (Stewart et al. 2004), so that a lower proportion of the annual discharge will occur during spring and summer.

The effect that climate change could have on KWS dace is unknown at this time. This is currently a worldwide threat and, to be controlled, will likely require a united effort of all humanity especially from cultures currently burning large quantities of fossil fuels. KWS dace currently inhabits water which is geothermally warmed to a temperature of around 29.4°C (85°F). A drastic increase in the temperature of the spring water could lead to temperatures which are too high for the dace to survive and reproduce. Lower precipitation levels caused by global climate change could lead to reduced flows of the Kendall Warm Springs and a reduction of available habitat for the dace.

During the most recent (June 2007) population survey, water levels observed in the Kendall Warm Springs system were low with many drying mudflats in areas that previously served as fry nursery areas. The Green River adjacent to the Kendall Warm Springs also had below normal flow due, in part, to the below normal snowpack of the previous winter.

Preliminary analysis of the data obtained during the June 2007 sampling indicated that the KWS dace population may be at lower levels than previous sampling years. Mean CPUE in 2007 was roughly half of mean CPUE in 2005. It is uncertain at this time if such changes are within the normal range of variability for this species and its habitat. Temperature of the water of the Kendall Warm Springs recorded during the 2007 sampling period was similar to that recorded in previous sampling years.

Climate change is a potentially imminent and future threat. Following recent (June 2007) observations, we feel the threat of climate change to the population may be moderate in intensity with a moderate exposure level. Climate change could potentially be contributing to the reduction of overall abundance of KWS dace. However, a large degree of uncertainty exists regarding the extent of such effects. For these reasons, we rank the overall threat level for this threat as currently **moderate**. Further studies should be conducted to determine the need for strategies to monitor and minimize the effects of this potential threat.

2.4.2.7.4 Lack of Scientific Knowledge/Monitoring

The lack of scientific knowledge of KWS dace may cause the species to be managed below optimal levels. This is a rangewide threat as the dace is only found in one short stream. However, opportunities for better management of the species could potentially be missed. For instance, if we knew that the species would be adversely affected by a certain contaminant or other factor, then we could take preventative measures to minimize that impact. We feel that the exposure level for this threat is small. Given the overall effective management of the species during the last 40 years, we give this threat an overall threat level of **low**.

2.4.2.7.4 Threats Associated with Small Population Size

Stochastic, or random, changes in a wild population’s demography or genetics, can threaten its persistence (Brussard and Gilpin 1989; Lacy 1997). A stochastic demographic change such as a skewed age or sex ratio (for example, a sudden loss of adult females) could negatively affect reproduction, especially in a small population. Disruption in gene flow due to reduction and isolation of populations may create unpredictable genetic effects that could impact the KWS dace’s existence.

Species with small population size and restricted distribution are vulnerable to extinction by natural processes and human disturbance (Levin et al. 1996). Random events causing population fluctuations or population extirpations become a serious concern when the number of individuals or the geographic distribution of the species is very limited. A single human-caused or natural environmental disturbance could destroy the entire population of KWS dace.

When a population's genetic variability falls to low levels, its long-term persistence may be jeopardized because its ability to respond to changing environmental conditions is reduced. In addition, the potential for inbreeding depression increases, which means that fertility rates and survival rates of offspring may decrease. Although environmental and demographic factors usually supersede genetic factors in threatening species viability, inbreeding depression and low genetic diversity may enhance the probability of extinction of rare species (Levin et al. 1996).

Because there is only one population of KWS dace in one geographic area, any detrimental impacts which are negatively affecting the population are affecting the entire KWS dace population. The lack of more than one KWS dace population may increase the likelihood of its extinction. The overall threat level for this threat is **moderate** and action is needed. Establishing refugia populations has been discussed; to date, no refugia populations have been established. The KWS dace have never been documented to reproduce in captivity. Their captive rearing would be very important to the establishment of refugia populations.

2.4.2.7.6 Toxins

Toxins may enter the Kendall Warm Springs ecosystem a number of ways. Potential sources of toxins include--(1) the use of soaps, detergents, sunscreens, or bleaches in the Kendall Warm Springs, (2) oil and gas development, (3) vehicle use on the bridge which crosses the Kendall Warm Springs ecosystem, (4) road construction/maintenance activities, or (5) fire suppression activities. Effects to dace could include--(1) direct poisoning, (2) impaired reproduction of the species, or (3) poisoning of the dace's food supply. As this dace occurs in only one location, this threat is considered a rangewide threat.

At one time, the use of soaps, detergents, and bleaches may have been of moderate/high intensity. The use of such materials has been prohibited since 1975. The dace currently are not exposed to this threat.

Toxins from oil and gas development have not been known to have stressed the KWS dace population in the past. However, toxins associated with this activity could stress the dace population in the future through impacts to the underground aquifer. The scope of the threat of oil and gas development is moderate. The exact recharge area of the spring is not known with certainty and could extend across multiple watersheds. Currently no deleterious effects from oil and gas development are realized by the population as this is a potential threat. If this threat does materialize, the exposure level would be very significant as 100% of the population would be exposed. Significant mortality and possible extinction of the species could be realized within a very short time. Given the push for increased oil and gas development in Sublette County, Wyoming, the overall threat level for this source of toxins is **high**. If drilling in the area is pursued, the overall threat level for this threat could quickly become severe with immediate action being essential for survival of the KWS dace. Conservation measures to minimize this threat have not yet been committed to by the relevant agencies. Proposed conservation measures include making the 21,270 ac (8,593 ha) of the springs' potential recharge area "administratively unavailable" for oil and gas leasing (Mattson 1998).

Photo provided by the U.S. Forest Service

FIGURE 13.
Bridge Over Kendall Warm Springs Stream

The use of vehicles on the bridge (Figure 13) over the dace's stream habitat could affect the dace population if--(1) a toxic spill occurs, (2) garbage is dumped, or (3) road salt or sediment is washed from the road into the stream. There have been no instances recorded of this activity historically occurring. Because (1) the road which crosses the bridge over the dace's stream habitat is the only access road to the heavily used Green River Lakes recreational area and campground and (2) recreational use of the area is likely to increase in the future, this threat could have more potential to affect the dace in the future. Depending on the extent of any inputs into the stream this could be a low/moderate threat. It is expected that up to 30% of the population would be affected, since only the lower ⅓ of the dace's habitat is downstream from the bridge crossing. Some habitat could be modified or dace mortality could occur as a result of poisoning.

If a wildfire did occur in the recharge zone for the Kendall Warm Springs, the fire suppression activities associated with that wildfire could have deleterious effects to the KWS dace population. Fire suppression activities could include increased vehicle traffic around the springs and the use of fire retardants. Fire retardants are often composed of either ammonia nitrate or surfactants. Ammonia nitrate is toxic to fish and could enter the spring water and poison the dace, or reduce or eliminate the aquatic plants or invertebrates present in the Kendall Warm Springs.

2.4.2.7.7 Other Natural Events

The potential for earthquakes, seismic activity, or great floods does exist for the dace's habitat. The area has been identified as an Intensity VII Earthquake Area (Case et al. 2002). USGS has estimated that a 4.2 to 4.5 magnitude earthquake might occur somewhere in the Green River Basin every 62 years (BLM 1999, as cited in BLM 2004).

The Yellowstone National Park region, located about 60 miles to the northwest, is a hotspot for geothermal, seismic activity and some major volcanic eruptions have occurred there in the past. The intensity of this threat if it were to occur could potentially be very high with a very significant exposure level and 100% of the KWS dace population affected. Significant mortality could result. Currently, the population is not known to be experiencing any effects from this threat and the likelihood is low that deleterious effects would materialize from this threat. Therefore, this threat is currently given a low overall threat level.

2.5 Synthesis

Once the impacts are expressed using ranking metrics, they may be compared across the array of known threats to which a species is exposed during its life cycle to evaluate the relative importance of each threat to the species' persistence and recovery, allowing the threats to be ranked in order of importance (USFWS 2006).

Much effort has been put into completing the recovery actions present in the recovery plan for the KWS dace (Table 1). Four of those recovery actions have been completed. Five more are perpetual in nature and are currently ongoing. No studies have yet been completed to monitor the effectiveness of the protective measures listed in the recovery plan. Life history studies have been partially completed; however, many aspects of the species biology still remain unknown.

Although the KWS dace population has currently been sustained and many recovery actions have been implemented, we recommend that this species remain classified as endangered at this time. The KWS dace remains highly vulnerable to many threats across all of its range given that it is known from only one small isolated population. The majority (87%) of the threats analyzed in this document were rangewide in scope (see Appendix B). Rangewide high intensity threats could materialize quickly across the species limited range causing extinction. The stressors analyzed in this document are either historic, imminent, or futuristic in time frame or a combination of these (see Appendix B).

The impacts associated with many "historic" threats have been minimized by conservation measures. Some of the potentially more deleterious historic threats include-bathing and the use of soaps, detergents, and other cleaning agents in the warm springs; impacts from excessive livestock; vehicle use over/through the fish's habitat; use of KWS dace as bait fish; road construction; and reservoir construction (see Appendix B). Some conservation measures to minimize the impacts of these threats include--fencing off the warm springs from entry by livestock, prohibiting the use of KWS dace as bait, prohibiting recreational activity in the warm springs, and replacing the original road culvert with a bridge crossing (Appendix C).

Only three threats were put into the "imminent" category (Appendix B). The three threats listed in the "imminent" category are--(1) absence of livestock from the species habitat, (2) climate change, and (3) lack of existing regulatory mechanisms independent of the ESA. These three threats are each given overall threat levels of moderate. The effect of the absence of livestock in the habitat to create dace fry "nursery habitat," should be evaluated in the future. However, other factors could be causing a reduction in the available habitat as well. Other theories should be evaluated that could be causing the observed narrowing of the stream channel. Such theories could include--(1) the replacement of the bridge culverts which previously may have acted as grade control structures, or (2) regional drought conditions causing reduced snowpack in the surrounding mountains leading to--(a) reduced groundwater recharge, (b) reduced spring discharge, and (c) a reduction in available habitat for the dace. Existing regulatory mechanisms independent of the ESA should be re-evaluated and should be strengthened to ensure that an adequate level of protection, and associated enforcement is provided to the KWS dace to ensure its recovery prior to removal of this fish from the List of Federally Threatened and Endangered Species.

Many (83%) of the threats analyzed in this document included potentially new "future" stressors. Some of these could manifest with relative ease causing devastating effects to the KWS dace population. The more deleterious future threats ranked with an overall "high" threat level include oil and gas development and introduction of exotic species into the Kendall Warm Springs area. Some future threats ranked with a "moderate" overall threat level include changes in habitat due to grazing exclusion, activities of vandalism, and climate change (Appendix B).

We recommend that all threats ranked with a “high” or “moderate” overall threat level be studied further and addressed in greater detail. Appropriate conservation measures should be adopted to minimize the impacts of these threats and appropriate management actions should be undertaken. We also recommend that the 1982 Recovery plan and the 1991 Recovery Plan Update be revised to include much needed objective measurable recovery criteria which will identify the requirements to be met prior to downlisting or delisting the species.

3.0 RESULTS

3.1 Recommended Classification

______ Downlist to Threatened
______ Uplist to Endangered
______ Delist
_______ *Extinction*
_______ *Recovery*
_______ *Original data for classification in error*
__X__ No change is needed

3.2 New Recovery Priority Number

Recommend a change from Recovery Priority Number 12 to Recovery Priority Number 12C.

Brief Rationale: The KWS dace is a subspecies with a moderate degree of threat and low recovery potential. The KWS dace may be in conflict with development projects (indicated by the letter “C”) in the future which were not adequately addressed in the recovery plan (USFWS 1982). The recovery plan also did not include measurable criteria for assessing progress toward recovery.

3.3 Listing and Reclassification Priority Number

Not applicable.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

TABLE 8.
Recommendations for Future Actions

1	Establish recovery team.
2	Charge recovery team with recommending a course of action regarding the following recommendations (USFS 1993, 1998).
3	Charge recovery team with revising the Kendall Warm Springs Dace Recovery Plan (USFS 1993, 1998).
4	Establish buffers to minimize impacts from oil & gas development & locatable mineral mining (see BLM 2002, Mattson 1998, or USFS 2000).
5	Evaluate the potential for classifying the Kendall Warm Springs ecosystem as a Special Management Area (USFS 1993).
6	Discuss potential need for establishment of refugia populations (USFS 1993, 1998).
7	Formulate habitat monitoring design for instream & riparian habitat (USFS 1993, 1998).
8	Draft Memorandum of Understanding (USFS 1993) or Cooperative Agreement (USFS 1998) to formalize cooperative efforts.
9	Seek section 6 funding & other funding opportunities to address needs as identified by the recovery team (USFS 1993, 1998).
10	Acquire more information regarding the Kendall Warm Springs hydrology & surrounding geology.
11	Establish a baseline characterization of the occupied aquatic habitats & develop a habitat monitoring program for several variables (e.g., discharge, temperature, water chemistry, widths, depths, photo points, transects, potential introduction of exotics) & incorporate this into the regular monitoring protocol.
12	Monitor the population abundance more frequently (e.g., every other year).
13	Discuss the potential need for frequent genetic monitoring to allow detection of a genetic contamination incident from the introduction of other dace species into the spring—Develop a genetic monitoring protocol if deemed necessary.
14	Cooperate with other agencies & parties to ensure that adequate cooperative strategies are in place to address monitoring for & control & eradication of potential exotic species introductions in nearby habitats that could increase the threat risk to the Kendall Warm Springs system.
15	Discuss the potential need for an improved interpretive sign.

5.0 REFERENCES (***** denotes peer-reviewed document)

*****Barry, R.G., and A. Seimon. 2000. Research for Mountain Area Development: Climatic Fluctuations in the Mountains of the Americas and Their Significance. A Journal of the Human Environment 29(7):364-370.

Bartlein, P.J., C.W. Whitlock, and S.L. Shafer. 1997. Future climate in the Yellowstone National Park Region and its potential impact on vegetation. Conservation Biology 11(3):782-792.

Besson, M. 2007. Wyoming Water Commission. Personal Communication with Alex Schubert, U.S. Fish and Wildlife Service, Wyoming Ecological Services Field Office, Cheyenne, Wyoming, on April 3, 2007.

Binns, N.A. 1972. An inventory and evaluation of the game and fish resources of the Upper Green River in relation to current and proposed water development programs. A Thesis Submitted to the Department of Zoology and Physiology and the Graduate School of the University of Wyoming in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy. University of Wyoming, Laramie.

Binns, N.A. 1978. Habitat Structure of Kendall Warm Springs, With Reference to the Endangered Kendall Warm Springs Dace, *Rhinichthys osculus thermalis*. Fisheries Technical Bulletin No. 4, Wyoming Game and Fish Department, Cheyenne. 45 pp.

Binns, N.A. 2007. Subject: Review of “Draft Kendall Warm Springs dace 5-year review.” Received by U.S. Fish and Wildlife Service, Cheyenne Ecological Services Field Office, June 15, 2007. 4 pp.

*****Brussard, P.F., and M.E. Gilpin. 1989. Demographic and genetic problems of small populations. Pg. 37-48 in Conservation biology of the black-footed ferret (U.S. Seal, E.T. Thorne, M.A. Bogan, and S.H. Anderson, eds.). Yale University Press, New Haven, Connecticut. 302 pp.

Case, J.C., R.N. Toner, and R. Kirkwood. 2002. Basic Seismological Characterization for Sublette County, Wyoming. Wyoming State Geological Survey Report. Available online at http://www.wrds.uwyo.edu/wrds/wsgs/hazards/quakes/seischar/Sublette.pdf

Cayan, D., S. Kammerdiener, M. Dettinger, J. Caprio, and D. Peterson. 2001. Changes in the Onset of Spring in the Western United States. Bulletin of the American Meteorological Society 82(3):399-415.

*****Deacon, J.E., C. Hubbs, and B.J. Zahuranec. 1964. Some effects of introduced fishes on the native fish fauna of southern Nevada. Copeia 1964(2):384-388.

*****Dowling, T.E., and M.R. Childs. 1992. Impact of Hybridization on a Threatened Trout Of the Southwestern United States. Conservation Biology 6(3):355-364.

*****Echelle, A.A., and P.J. Connor. 1989. Rapid Geographically Extensive Genetic Introgression after Secondary Contact between Two Pupfish Species (*Cyprinodon, cyprinodontidae*). Evolution 43(4):717-727.

Fertig, W. 1995. Biological Report on the Potential Kendall Warm Springs Special Management Area. Prepared for the USDA Forest Service, Bridger-Teton National Forest. Wyoming Natural Diversity Database, The Nature Conservancy, Laramie, Wyoming. 59 pp.

*****Gould, W.R., and C. Kaya. 1991. Pharyngeal Teeth in the Endangered Kendall Warm Springs Dace (*Rhinichthys osculus thermalis*). Copeia 1991(1):227-229.

Gryska, A.D. 1996. Development of Population Monitoring Protocols and Description of Several Life History Aspects of Kendall Warm Springs Dace *Rhinichthys osculus thermalis.* Unpublished master’s thesis, University of Wyoming, Laramie.

Gryska, A.D. 2006. Fishery Biologist. Alaska Department of Fish and Game. Personal communication with Alex Schubert, U.S. Fish and Wildlife Service, Cheyenne Ecological Services Field Office on December 19, 2006.

Gryska, A.D., and W.A. Hubert. 1995. Development of Population Monitoring Techniques and Description of Life History Parameters for the Kendall Warm Springs dace – Progress Report. Progress Report submitted to the U.S. Fish and Wildlife Service in fulfillment of obligations under Cooperative Agreement No: 14-48-0009-94-1542, Research Work Order 128. 4 pp.

*****Gryska, A.D., and W.A. Hubert. 1997. Observations on the Reproduction, Sources of Mortality and Diet of the Kendall Warm Springs Dace. Great Basin Naturalist 57(4):338-342.

*****Gryska, A.D., W.A. Hubert, and K.G. Gerow. 1997. Use of power analysis. North American Journal of Fisheries Management 17:1005-1009.

*****Gryska, A.D., W.A. Hubert, and K.G. Gerow. 1998. Relative abundance and lengths of Kendall Warm Springs Dace captured from different habitats in a specially designed trap. Transactions of the American Fisheries Society 127:309-315.

*****Hall, M.H.P., and D.B. Fagre. 2003. Modeled climate-induced glacier change in Glacier National Park, 1850-2100. BioScience 53(2):131-140.

Hubbs, C.L., and E.R. Kuhne. 1937. A New Fish of the Genus *Apocope* From a Wyoming Warm Spring. Occ. Papers, Museum of Zoology. University of Michigan, 343:1-21.

Huda, P. 2007. Fire Management Officer. U.S. Forest Service, Pinedale Ranger District. Personal communication with Alex Schubert U.S. Fish and Wildlife Service, Cheyenne Ecological Services Field Office on January 22, 2007.

Kaya, C.M., P.F. Brussard, D.G. Cameron, W.R. Gould, and E.R. Vyse. 1988. Progress Report Submitted to U.S. Fish and Wildlife Service Endangered Species Office Denver, Colorado – A Comparison of morphology, thermal tolerances, and biochemical genetics of the Kendall Warm Springs dace (*Rhinichthys osculus thermalis*) and speckled dace (*R. osculus yarrowi*) of the Green River drainage in Wyoming. 9 pp.

Kaya, C.M., P.F. Brussard, D.G. Cameron, W.R. Gould, and E.R. Vyse. 1989. A Comparison of morphometrics, thermal tolerances, and biochemical genetics of the Kendall Warm Springs dace (*Rhinichthys osculus thermalis*) and speckled dace (*R. o. yarrowi*) of the upper Green River drainage in Wyoming. Project Report Submitted to the U. S. Fish and Wildlife Service Endangered Species Office, Denver, Colorado. 32 pp.

*****Kaya, C.M., P.F. Brussard, D.G. Cameron, W.R. Gould, and E.R. Vyse. 1992. Biochemical Genetics and Thermal Tolerances of Kendall Warm Springs Dace (*Rhinichthys osculus thermalis*) and Green River Speckled Dace (*Rhinichthys osculus yarrowi*). Copeia 1992:528-535.

Lanteigne, J. 1987. Status Report on the Banff Longnose Dace (*Rhinichthys cataractae smithi*). Committee on the Status of Endangered Wildlife in Canada. 19 pp.

*****Lacy, R.D. 1997. Importance of Genetic Variation to the Viability of Mammalian Populations. Journal of Mammalogy 78(2):320-335.

*****Levin, D.A., J. Francisco-Ortega, and R.K. Jansen. 1996. Hybridization and the Extinction of Rare Plant Species. Conservation Biology 10(1):10-16.

Mattson, L.L. 1998. Hydrogeologic Evaluation of Kendall Warm Springs, Bridger-Teton National Forest. Specialists Report, Manti-La Sal National Forest. 7 pp.

*****McAllister, D.E. 1969. Introduction of Tropical Fishes into a Hotspring near Banff, Alberta. The Canadian Field-Naturalist 83:31-35.

Neal, J. 2006. Fisheries Biologist. U.S. Forest Service, Pinedale Ranger District. Personal communication with Alex Schubert, U.S. Fish and Wildlife Service, Cheyenne Ecological Services Field Office on December 8, 2006.

Nico, L. 2006. *Poecilia reticulata*. USFS Non-indigenous Aquatic species Database, Gainesville, Florida. <http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=863>

Nico, L., and P. Fuller. 2006. *Cichlasoma nigrofasciatum*. USGS Non-indigenous Aquatic Species Database, Gainesville, Florida. <http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=447>

*****Rahel, F.J. 2000. Homogenization of Fish Faunas Across the United States. Science 288:854-856.

*Renaud, C.B., and D.E. McAllister. 1988. Taxonomic status of the extinct Banff longnose dace, *Rhinichthys cataractae smithi*, of Banff National Park, Alberta. Environmental Biology of Fishes 23:95-113.

Roth, S. 2007. Fishery Biologist, U.S. Fish and Wildlife Service. Personal communication with Alex Schubert, U.S. Fish and Wildlife Service, Cheyenne Ecological Services Field Office on February 15, 2005.

Stewart, I., D.R. Cayan, and M.D. Dettinger. 2004. Changes in snowmelt runoff timing in western North America under a 'Business as Usual' climate change scenario. Climatic Change 62:217-232.

U.S. Bureau of Land Management. 1999. Environmental Assessment for the Bird Canyon-Opal Pipeline, Granger Spur Pipelines, and One Compressor Station, Sublette, Sweetwater, and Lincoln Counties, Wyoming. Rock Springs Field Office, Rock Springs, Wyoming, and Kemmerer Field Office, Kemmerer, Wyoming. MAI Project 24822. February.

U.S. Bureau of Land Management. 2002. Final Programmatic Biological Assessment for the Kendall Warm Springs Dace in Wyoming. USDI-BLM, Cheyenne, Wyoming. 12 pp.

U.S. Bureau of Land Management. 2004. Environmental Assessment for the Questar Year-Round Drilling Proposal, Sublette County, Wyoming. Pinedale, Wyoming. 80 pp.

U.S. Fish and Wildlife Service. 1982. Kendall Warm Springs Dace Recovery Plan. U.S. Fish and Wildlife Service, Denver, Colorado. 30 pp.

U.S. Fish and Wildlife Service. 1991. Kendall Warm Springs Dace (*Rhinichthys osculus thermalis*) recovery plan update—1991. 4 pp.

U.S. Fish and Wildlife Service. 2006a. Draft Guidance for Conducting Threats Assessments Under the ESA. Memorandum to Regional Directors from Director Hall dated October 20, 2006. 14 pp.

U.S. Fish and Wildlife Service. 2006b. Moapa dace webpage accessed December 22, 2006. <http://ecos.fws.gov/docs/life_histories/E002.html>

U.S. Forest Service. 1978. Kendall Warm Springs Biological Unit Management Plan. 1978. Unpublished report for the Bridger-Teton National Forest. 18 pp.

U.S. Forest Service. 1990. Bridger-Teton National Forest, Land and Resource Management Plan. 366 pp. + Appendices.

U.S. Forest Service. 1993. Kendall Warm Springs Dace Meeting Notes. USFS Memorandum dated July 30, 1993 to Bob Reese from Kurt Nelson. 2 pp.

U.S. Forest Service. 1997. Kendall Warm Springs Bridge Construction Report. Unpublished report by K.A. Nelson completed May 30, 1997. 5 pp.

U.S. Forest Service. 1998. Kendall Warm Springs Dace Meeting Notes. Notes taken by K.A. Nelson. Pinedale Ranger District. Meeting notes dated July 2, 1998. 1 page.

U.S. Forest Service. 2000. Oil and Gas Leasing Draft Environmental Impact Statement. Intermountain Region, Bridger-Teton National Forest, Jackson, Wyoming.

U.S. Forest Service. 2003. U.S. Forest Service correspondence to U.S. Bureau of Land Management informing of decision not to authorize the leasing of Bridger-Teton National Management Areas 21, 45, 71, and 72 in Wyoming. U.S. Forest Service letter dated March 7, 2003. 3 pp. + enclosure.

U.S. Forest Service. 2006. U.S. Forest Service unpublished report to the U.S. Fish and Wildlife Service describing Kendall Warm Springs dace monitoring activities conducted in June 2005 according to Subpermit #TE-106387. Report dated January 6, 2006. 5 pp.

Wyoming Game and Fish Department. 2007a. Wyoming Game and Fish Commission Regulations Chapter 52. Website accessed March 12, 2007. <http://gf.state.wy.us/admin/regulations/chapter52/ch52nong.htm>

Wyoming Game and Fish Department. 2007b. Wyoming Game and Fish Commission 2006 through 2007 Wyoming Fishing Regulations. 32 pp. <http://gf.state.wy.us/downloads/pdf/fishregs.pdf>

Appendix A
U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE FOR 5-YEAR REVIEW
on Kendall Warm Springs dace (*Rhinichthys osculus thermalis*)

CURRENT CLASSIFICATION – Endangered

PRE-1996 DPS LISTING CONSISTENT WITH DPS POLICY? – Not applicable

RECOMMENDATION resulting from the 5 – Year Review

_______ Delist _______ Endangered to Threatened

_______ Threatened to Endangered ___X__ No Change

APPROPRIATE LISTING/RECLASSIFICATION PRIORITY NUMBER – Not applicable

REVIEW CONDUCTED BY – Region 6, Cheyenne Ecological Services Field Office

Lead Assistant Regional Director
Ecological Services, Fish and Wildlife Service
Region 6

Mike Stempel ______ 10/10/07 ______
Signature Date

Lead Regional Director
Fish and Wildlife Service
Region 6

Elliott Sutta ______ 10/10/07 ______
Concur Date

______________ ______
Not concur Date

Field Supervisor
Ecological Services, Fish and Wildlife Service
Wyoming Ecological Service (ES) Field Office

B. T. Kelly ______ 9/13/07 ______
Concur Date

______________ ______
Not concur Date

APPENDIX B.
Kendall Warm Springs Dace
Threats, Stressors, and Their Associated Scope, Immediacy, Intensity, Exposure,Response, and Overall Threat Level Ratings

	Threat	Stressor Associated With Threat	Factor	Scope	Immediacy	Intensity	Exposure	Response	Overall Threat Level
1	Bathing & use of soaps, detergents, sunscreen, & bleaches in spring & creek	Poisoning of dace	A	rangewide	historic	low	insignificant	mortality	Low
		Poisoning of macroinvertebrates	A	rangewide	historic	low	insignificant	basic needs inhibited	Low
		Poisoning of plant community	A	rangewide	historic	low	insignificant	basic needs inhibited	Low
		Modification of water quality	A	rangewide	historic	low	insignificant	basic needs inhibited	Low
		Modification of habitat	A	rangewide	historic	low	insignificant	basic needs inhibited	Low
2	Personal aquaria, commercial trade purposes	Reduction in dace numbers in population	B	rangewide	future	low	small	removal from population	Low
3	Deleterious effects of research efforts	Reduction in dace numbers	B	rangewide	historic/future	low	small	mortality	Low
		Impaired reproduction/survival	B	rangewide	historic/future	low	small	basic needs inhibited	Low
		Introduction of disease	C	rangewide	future	moderate	moderate	mortality	Low
		Reduction in prey abundance/diversity	B	rangewide	historic/future	low	small	basic needs inhibited	Low
		Reduction of habitat quantity	A	rangewide	historic/future	moderate	small	basic needs inhibited	Low
		Reduction of habitat quality	A	rangewide	historic/future	moderate	small	basic needs inhibited	Low

	Threat	Stressor Associated With Threat	Factor	Scope	Immediacy	Intensity	Exposure	Response	Overall Threat Level
4	Oil & gas leasing, drilling, fraccing, flushing with warmer or colder water, flushing with surfactants, other fluids, reinjection of water, removing groundwater	Modification of aquifer by drilling activities	A	rangewide	future	high	significant	mortality (potential extinction)	High
		Changes in spring water quantity (drying up spring)	A	rangewide	future	high	significant	mortality (potential extinction)	High
		Changes in spring water quality (e.g., introduction of toxins from drilling, changes in water chemistry)	A	rangewide	future	high	significant	mortality (potential extinction)	high
5	Introduction of tropical or warm-water fish species, other *Rhinichthys* species, or other exotic aquatic species (e.g., zebra mussels, exotic snails, exotic plants) to spring. Introduction of parasites	Introduction of disease, impaired reproduction/survival, physiological changes	C	rangewide	future	high	significant	mortality (potential extinction)	high
		Predation on dace	C	rangewide	future	high	significant	mortality (potential extinction)	high
		Competition for important resources (habitat, food)	E	rangewide	future	high	significant	basic needs inhibited	moderate
		Upset of ecological balance	E	rangewide	future	high	significant	basic needs inhibited	high
		Potential hybridization.	E	rangewide	future	high	small	loss of genetic integrity	high

Threat		Stressor Associated With Threat	Factor	Scope	Immediacy	Intensity	Exposure	Response	Overall Threat Level
6	Changes in habitat due to exclusion of grazing animals from area	Reduction of “nursery areas” for dace fry [due to livestock physically creating these areas (pre-1975) from wading & wallowing in stream & stream side]	A	rangewide	historic/imminent/future	moderate	moderate	basic needs inhibited	moderate
		Increased incision of stream channel (channel getting narrower & water velocity increasing)	A	rangewide	historic/imminent/future	moderate	moderate	basic needs inhibited	moderate
		Reduction of nutrients into spring (from cattle manure) thereby changing stream’s productivity (plant community, macroinvertebrates, & dace productivity)	A	rangewide	historic/ imminent/future	low	moderate	basic needs inhibited	low
		Manipulation of streamside plant community succession due to exclusion of livestock grazing	A	rangewide	historic/imminent/future	low	small	unknown	low
7	Activities of vandalism (e.g., deliberate poisoning of KWS dace)	Reduction or elimination of dace population through poisoning or other malicious activity	E	rangewide	future	high	small	mortality (potential extinction)	moderate
8	Climate change	Changes in hydrological conditions, habitat conditions	E	rangewide	imminent/future	moderate	moderate	basic needs inhibited	moderate
9	Lack of (or inefficiency of) existing regulatory mechanisms independent of ESA	Insufficient protective measures	D	rangewide	historic/imminent/future	moderate	moderate	various	moderate
10	Livestock grazing (livestock crossing fence & watering in spring)	Siltation of habitat	A	rangewide	historic	high	small	basic needs inhibited	low
		Pollution of habitat	A	rangewide	historic	high	small	basic needs inhibited	low
11	Vehicle use on bridge over stream	Potential for toxic spill, garbage	E	localized	historic/future	low	small	behavioral (avoidance, startle, mortality)	low

	Threat	Stressor Associated With Threat	Factor	Scope	Immediacy	Intensity	Exposure	Response	Overall Threat Level
12	Use of KWS dace as a bait fish	Reduction of numbers of dace	B	rangewide	historic	high	insignificant	mortality confirmed	low
13	Road construction, Improvement	Siltation of habitat	E	localized	historic/future	low	small	behavioral (avoidance)/ basic needs inhibited	low
		Pollution of habitat	E	localized	future	low	small	behavioral (avoidance)/ basic needs inhibited	low
14	Increased recreational use of area	Illegal take of dace	B	rangewide	future	moderate	small	removal from population	low
		Modification of habitat by bathers	A	rangewide	historic	low	small	behavioral (avoidance)/ basic needs inhibited	low
15	Lack of scientific knowledge	Potentially inadequate management of species	E	rangewide	historic/future	low	small	various	low
16	Lack of monitoring	Potential failure to detect meaningful changes in population, habitat, prey, etc.	E	rangewide	historic/future	low	small	various	low
17	Reservoir construction (changes in hydrology, etc.)	Changes in spring flow, inundation of the spring	A	rangewide	historic/future	high	insignificant	mortality (potential extinction)	low
18	Catastrophic wildfire	Changes in hydrology	A	rangewide	future	moderate	small	basic needs inhibited	low
		Changes in siltation rates	A	rangewide	future	moderate	small	basic needs inhibited	low
19	Fire suppression activities	Increased vehicular traffic around spring	E	rangewide	future	low	small	basic needs inhibited	low

	Threat	Stressor Associated With Threat	Factor	Scope	Immediacy	Intensity	Exposure	Response	Overall Threat Level
20	Fire retardants	Pollution of spring	E	rangewide	future	high	small	basic needs inhibited/ mortality	low
		Poisoning of dace	E	rangewide	future	high	small	mortality	low
		Impaired reproduction/survival	E	rangewide	future	high	small	basic needs inhibited/ mortality	low
		Poisoning of macroinvertebrates	E	rangewide	future	high	small	basic needs inhibited	low
		Poisoning of plant community	E	rangewide	future	high	small	basic needs inhibited	low
		Modification of water quality	E	rangewide	future	high	small	basic needs inhibited/ mortality	low
21	Acid rain	Change in water chemistry	A	rangewide	future	low	small	unknown	low
22	Natural catastrophe (earthquake)	Change in hydrology	E	rangewide	future	low	small	unknown	low
23	Herbicide, pesticide use	Contamination of dace's habitat	A	localized	future	low	small	basic needs inhibited/ mortality	low
		Decrease in aquatic vegetation of habitat	A	localized	future	low	small	basic needs inhibited	low
		Reduction in invertebrate numbers	A	localized	future	low	small	basic needs inhibited	low

Factors - A = The present or threatened destruction, modification, or curtailment of its habitat or range
B = Overutilization for commercial, recreational, scientific, or educational purposes
C = Disease or predation
D = The inadequacy of existing regulatory mechanisms
E = Other

Scope - Geographic extent of threat factor occurrence
Immediacy - Time frame of stressor
Intensity - Strength of stressor
Exposure - Level of total known population exposed to threat source
Response - Level of physiological/behavioral response
Overall Threat Level – Integration of the scope, immediacy, intensity, exposure, and response at the species level

APPENDIX C.
Implemented Conservation Measures

1	The area around Kendall Warm Springs (160 acres) was withdrawn from mineral entry in 1962. (Note--This mineral withdrawal only applies to "locatable" minerals such as gold, silver, precious gems, etc. This mineral withdrawal does not apply to "leaseable" minerals such as oil, gas, or coal or "salable" minerals such as sand and gravel.)
2	In 1969, the Forest Service enclosed 160 acres surrounding three sides of the spring area to protect it from further impact.
3	Wyoming Game and Fish Department prohibited the use of Kendall Warm Springs dace as bait.
4	In 1970, the Kendall Warm Springs dace was designated as an endangered species.
5	Bathing, wading, and the use of soaps, detergents, and bleaches in the spring and creek was prohibited in 1975.
6	Vehicle access was blocked off from the spring area.
7	Parking lot was designated.
8	An interpretive sign explaining the dace's significance was posted in 1975.
9	The Kendall Warm Springs Biological Unit was identified by the Forest Service in 1978 and consisted of 160 acres.
10	Some life history studies have been completed.
11	Culverts have been removed and bridge crossing completed.
12	Area evaluated as potential Research Natural Area.
13	Taxonomic studies were undertaken and have concluded it is a separate subspecies.
14	Population monitoring techniques have been developed.
15	Population and habitat monitoring activities are ongoing.
16	A hydrologic study was completed in 1998.